

THE LARYNGOSCOPE.

VOL. LI

AUGUST, 1941.

No. 8

RHINOLOGY IN CHILDREN, RESUME OF AND COMMENTS ON THE LITERATURE FOR 1940.

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The same 10 journals are reviewed which were reviewed in the referats of 1938 and 1939. The articles abstracted have been roughly classified under various headings following the order used hitherto. Again, no comment is made on articles from the totalitarian countries. Free thought and the free expression of that thought are essential to the production of trustworthy medical papers.

GENERAL ARTICLES ON ACCESSORY SINUS DISEASE IN CHILDREN.

Douglas Guthrie¹ contributes a short, clear resumé of the general subject of nasal sinusitis in children, giving an account of the anatomy and development of the nasal sinuses, discussing the frequency of sinusitis in children and its clinical manifestations. He describes local conservative treatment — lavage of maxillary sinuses, and discusses antrostomy and radical operation. He states that the puncture and washing out of the maxillary sinus is the generally accepted method of diagnosis and treatment and advises that the washing be done with the patient in the prone position, using a straight trocar and cannula.

Simpson² states that irrigation of the antrum through either the inferior or the middle meatus, is probably done much more often than all other operative procedures on the nose. It seems to him that of great importance is the care

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, Aug. 1, 1941.

with which the irrigation is performed. If proper attention is given, practically no complications should be encountered. He emphasizes, "I have never encountered anything but good results in washing acutely diseased antra and see no good reason for not carrying out this procedure."

DIAGNOSIS OF ACCESSORY SINUS DISEASE.

Waldapfel³ discusses the question of whether or not X-ray examination of the maxillary sinuses is superior to simple transillumination. In the diagnosis of an abnormal condition of the maxillary sinus, he gives the preference to the X-ray because of its more exact and, in most instances, more definite method of diagnosis. For, in the simple transillumination, a difference in darkness of the maxillary sinus can be caused not only by disease of the sinus but also by: 1. asymmetry of the two sinuses; and 2. varied thickness of the bone; these anomalies do not play a part in the X-ray examination and do not influence the result.

He gives the case history and differential diagnosis of a patient, age 11 years, who damaged her face by a fall which hit the right upper jaw. Transillumination of the right side was completely dark, while the X-ray was entirely negative. This showed that a slight swelling of the skin and subcutaneous tissue infiltration are sufficient to cause the highly positive findings. [The author transilluminated his patient by palatofacial route and did not transilluminate his patient by the orbitopalatal route.—ED.]

The author draws the following conclusions: 1. Apart from disease of the maxillary sinus itself, darkness in transillumination can be caused not only by thickness of the bony walls and asymmetry of the maxillary sinus, but as well and still much more by infiltration of the soft parts, even of slightest degree. In such cases the transillumination shows more than the X-ray. 2. Complete or massive cloudiness of the maxillary sinus in transillumination with negative X-ray findings is to be regarded as significant for infiltration of the soft parts, subcutaneous edema or hematoma (even if no considerable swelling or discoloration of the skin is to be seen).

The contention that X-ray of the maxillary sinuses is superior to the simple transillumination must be denied in certain

cases, as the one described, wherein the transillumination is definitely superior. Not transillumination or X-ray, but transillumination and X-ray have to be done in every doubtful case; they do not substitute one for the other but complete themselves as substantiating evidence.

Bilchick⁴ states that because of its location and its relation to surrounding important areas, the sphenoid sinus is relatively difficult to approach and diagnosis is extremely doubtful at times. Every diagnostic effort and procedure may be necessary to establish the diagnosis and to eliminate possibilities of other anomalies. If no definite diagnosis can be made, one should not hesitate to explore the sphenoid sinus in suitable cases, as the vision may be at stake.

In support of his contention, he states that the diagnosis of mastoiditis or petrositis has been made in the presence of a running ear when the lesion really was purulent sphenoiditis.

He illustrates this by the following case: H. C., age 9 years, was admitted to the hospital on Dec. 12, 1936, with a history of fever (temperature, 103° F.), and swollen neck of five days' duration and of unconsciousness for one day. Examination revealed a red, drooping canal wall together with swelling of the neck and parotid gland, as well as weakness in the lower part of the face. No pus could be seen in the nose. Roentgenograms showed no sinusitis; the sphenoid bone was not pneumatized. The mastoid antrum was hazy, and there was a profuse discharge from the left ear. A left simple mastoidectomy was performed but revealed no pathologic change. Spinal test yielded normal fluid. The next day pus appeared in the left naris. Death occurred the day after the child's admission. Autopsy showed acute sinusitis involving the left antrum and the ethmoid and sphenoid sinuses, as well as an abscess in the sphenoid sinus, and cavernous sinus thrombosis due to *staphylococcus aureus hemolyticus*.

The clinical symptoms of sphenoid sinusitis differ from those of maxillary, frontal and ethmoid sinusitis, in that the location of the pain is different, the findings are fewer and the discharge more elusive and the complications more varied. In general, the diagnosis is more difficult. The pain is usually frontal, occipital or just behind the eyes. It may, how-

ever, be referred to the mouth at the junction of the soft palate and the anterior tonsillar pillars, to the vertex or to the mastoid process. The onset of pain may be sudden or gradual. It may be dull, throbbing, pounding, sickening, stabbing or burning. Other frequent complaints are malaise, sleeplessness, vertigo, tickling cough, postnasal drip, scabs in the pharynx, gastric disorders and diminished olfaction. When complications ensue, there may be visual disturbances or paralyses. In cases of acute purulent infection, meningitis or cavernous thrombosis may result. Examination may show little of importance by direct anterior rhinoscopic examination and by posterior rhinoscopic examination with a mirror, and even with the nasopharyngoscope one may find little that is pathologic. The difficulties are tremendously increased by a large middle or inferior turbinate or by a deviated nasal septum. The secretion may be transient and scanty. If it is seen behind the posterior end of the middle turbinate, or on the posterior end of the middle turbinate, in the sphenoid-ethmoid recess or around the sphenoid ostium, sphenoiditis is suggested.

Roentgenograms are of material assistance to the diagnosis. Lateral positions, as well as mentovertical positions, should always be utilized. The Granger position may be used. The mentovertical position is taken with the patient prone and the extended chin on the Roentgenogram. It shows the comparative structure, as well as the pathological condition of the two sphenoid sinuses.

Crowe⁵ finds the recurrence of adenoids after operation on young children so common that it must be regarded as normal. Adenoids recur in more than 75 per cent of those whose tonsils and adenoids have been removed before the age of puberty. The explanation for the recurrence of lymphoid nodules in the oro- and nasopharynx is that lymphoid tissue is an integral part of the mucous membrane in this area, and it is impossible to remove all of it at operation. [This statement deserves reiteration until the fact becomes taught universally in pediatrics.—ED.]

Crowe⁶ emphasizes necessity for the thorough examination of the nasopharynx of children by the nasopharyngoscope. He uses a 20 per cent solution of cocaine hydrochloride. He

moistens a cotton-tipped applicator with this solution, wringing out the excess, and applies this to the floor of the nose. This solution has not produced any reaction in the children who have been examined this year, and they were examined at the rate of 30 to 50 a day by a group of persons who do nothing else. No excess cocaine is allowed to run down the throat and be absorbed. The solution has no toxic effect whatsoever. It is much better than a 5 or 10 per cent solution because it takes a shorter time. He states that of 1,400 children seen, 8 and 14 years of age, 1,365 were perfectly satisfactory on examination — just as satisfactory as any adult, but the examinations were done where the rest of the children could see the one undergoing the test. One who does not seem to be too high-strung and nervous is chosen for the first examination, and then the rest of the children are allowed to observe that the examination is perfectly simple and easy.

Mitchell⁷ declares that development of the sinuses depends on the establishment of proper pneumatization. An individual with normally developed sinuses may have attacks of acute sinusitis; chronic sinusitis, however, is associated with deficient development. The undeveloped sinus is usually diseased. When the tonsils are removed early in life, additional work is thrown on the sinuses, which play a part against diseases that may arise from infections of the upper part of the respiratory tract. Kaiser on an examination of school children with and without tonsils found sinus infection more prevalent in those whose tonsils had been removed during their early years. In addition to general physical study, every patient with sinusitis should have an allergic study. In allergic sinusitis, in addition to other symptoms, the mucous membrane is pale and the secretion is fluid. In chronic sinusitis from infection, the mucous membrane of the posterior nares, particularly in the region of Waldeyer's ring, is boggy and red and secretes a thick mucus. Frequently both infection and allergy play a part.

Bernfeld⁸ attempts to establish a relationship between inflammatory processes in the nasal mucous membranes of both infants and younger children and the normal rate and extent of pneumatization of the sinuses. In an analysis of a group of children between the ages of 8 and 14 years, who

were troubled with marked adenoid hypertrophy, Roentgen examination did not reveal any appreciable influence on the size and shape of the sinuses as compared with children who had not had any of these hyperplastic recurrent infections. He analyzed another group of patients who suffered from acute or chronic rhinitis (from birth or early infancy, with or without adenoid hypertrophy), syphilis, diphtheria or ozena, and in these patients, too, could find no evidence of an influence on the rate of pneumatization of these sinuses.

In summarizing, he states:

1. The variability of the pneumatization of the sinuses is a direct consequence of a manifold process associated with the development of the bones of the skull.
2. Hereditary factors play a decisive rôle in regard to constancy as an individual variation.
3. Inflammatory conditions of the nasal mucosa do not exert any appreciable influence on the degree of pneumatization of the sinuses.
4. The normal process of the development of the sinuses and the rhythm of pneumatization are strongly influenced by dysfunction of the endocrine glands.
5. Hence, it is probable that the physiologic variations in pneumatization are directly influenced by endocrine function.

COMPLICATIONS OF ACCESSORY SINUS DISEASE.

Bucy and Haverfield⁶ in a profusely illustrated article describe three cases of cranial and intracranial complications of acute frontal sinusitis which followed swimming, and one case in which the infection followed trauma to a stye. The patients' ages lay between 16 and 3 years. In all, the infection was severe, the operations very extensive, but recovery occurred.

The authors concluded:

1. The infection usually spread to the frontal bone and invades the brain by way of the venous system.
2. Prevention of the fulminating frontal sinusitis, osteomyelitis and brain abscess, which so often follow swimming,

can in a measure be attained by instruction regarding proper breathing and the use of protective devices. However, in the main, prophylactic measures must be directed towards prevention of the spread of infection from the sinus. It appears that this can be best attained by prompt external facial drainage in the acute fulminating cases.

3. Osteomyelitis of the skull should be treated by excision of all of the infected bone as soon as diagnosis is made.

4. Brain abscess should be drained through an uninfected area of the skull, if possible, with due attention to prevention of infection of the meninges.

5. Defects made by removing infected bone from the skull are probably usually repaired by the spontaneous regeneration of bone.

The authors give their technique of treating brain abscess.

Lewy¹⁰ states that osteomyelitis of the frontal bone in the absence of a predisposing frontal sinus must be quite rare. One of his two cases was in a girl, age 8 years. The localization in the outer table was most probably explained by the greater porosity of the outer table of the bone as opposed to the more vitreous character of the inner table. This case represented a special surgical problem since it did not require the usual sinus approach and was in close proximity to the superior frontal sagittal sinus. The process developed in the midline at a point away from the place of origin of the frontal sinus.

Kisch¹¹ reported orbital cellulitis in a female child, age 12 years. There was swelling of the left orbit, and left nasal discharge, while X-ray examination showed opacity of the left antrum and the left ethmoidal region.

Lavage of the left antrum was repeated four times, the pus giving culture of hemolytic streptococcus. One tablet of prontosil was given every four hours for four days. Rapid improvement occurred, but swelling of the left upper and lower eyelid recurred and the eye proptosed. An external operation was performed and the frontal sinus and the ethmoidal region found full of pus, while the left antrum was found fairly clear on puncture.

An interesting discussion arose regarding the differential diagnosis between a thrombosed vein and a collection of pus in an extraperiosteal abscess. The important point was not the proptosis but the question whether the patient could move the eye. That was the first thing that gave one a reliable hint. Really severe limitation of movement of the eyeball indicated actual infection and not merely edema. Kisch made it clear that he did not say that he operated on every case directly he found acute inflammation, but that he operated directly he was certain in his own mind that pus was present. By operation he did not mean merely opening the abscess. In operating, also, he treated the case very gently, not using a burr or a rasp.

Paterson¹² records the case of a male child, age 2½ years, who developed the clinical picture of typical tetanus eight days after the initial convulsion. At any attempt to handle him, a spasm was provoked, with marked opisthotonus. For 12 days he was nasally fed entirely. When the nasal feeding was commenced, it was found that the posterior part of the nares on the left side was blocked with three lumps of coal as large as peas. These were removed and cultured, but no tetanus organisms were grown. He recovered in just four weeks from the onset of the illness.

TREATMENT OF ACCESSORY SINUS DISEASE.

Briant¹³ states that recent studies of the action of therapeutic procedures upon the function of the nose have brought new problems to be dealt with in the conservative treatment of sinusitis. His article does not deal specifically with sinusitis in children but is rather a discussion of the treatment of sinusitis in general. In spite of this, the thoughtful manner in which he discusses many of the prevalent ideas regarding the treatment of sinusitis makes the article of value to those more specifically interested with this aspect of the condition in children.

Dintenfass¹⁴ holds that in the treatment of acute sinusitis and acute rhinitis conditions, pediatricians should remember that the prime object is to assist Nature. Recalling that the three lines of defense against infection are: 1. the mucous film; 2. the ciliated epithelium; and 3. the highly vascular

submucosal stroma, one should employ remedial measures which do not disturb the function of these defense mechanisms. Local treatment of the nose should be mild and non-irritating. It can safely be said that the less intranasal treatment the better. Ephedrine and other shrinking solutions, while they produce temporary relief from nasal stuffiness, have the great disadvantage of causing secondary relaxation of the vascular layer of the submucous tissue, with resultant bogginess of the turbinate structure, interference with the normal flow of mucus, and disturbance of ciliary movement.

Dewanter¹⁵ discusses sinusitis in children from the viewpoint of diagnosis of conservative physiologic treatment and of results of pain. Emphasis is placed on the necessity for the more frequent recognition of sinusitis in children. He gives the histories of 11 patients. He advocates the displacement irrigation treatment and states that it is simple and painless; it does not further the popular dread of disease and treatment of the sinuses, and is in accord with all present concepts of the function of the nasosinal epithelium. The same procedure can also be of diagnostic value. The treatment as described gives early satisfactory relief in children suffering from nasal sinus infection. The secondary cough responds particularly well to the removal of its cause. The treatment greatly reduces the duration and frequency of disability of the upper respiratory tract.

Because ventilation of the nose and sinuses by vasoconstriction alone has become a recognized and widely used treatment, and for acute and subacute infections appears to be physiologically justified, Parkinson¹⁶ recommends the following formula as useful:

1. Water plus ephedrine sulphate to 1 per cent plus sodium chloride 0.68 per cent. 2. Boil. 3. Heat in boiled, screw-capped bottles.

Either distilled or tap water may be used. Tap water has been proved to be exceedingly advantageous. Natural drinking water usually is alkaline, and the alkalinity is reduced somewhat by the addition of ephedrine.

In the production of osmotic pressure, 1 per cent ephedrine is equal to 0.17 per cent sodium chloride; hence, if dilution of

the foregoing solution is desired, it should be made with an aqueous solution of 0.85 per cent sodium chloride.

Certain very desirable features characterize this solution.

1. Values for osmotic pressure and hydrogen ion concentration, physiologic.
2. Sterile, yet contains no antiseptic.
3. Stable in physical characteristics and effectiveness.
4. Odorless, colorless, clear.

The presence of this solution in the nasal fossa causes no sensation. This is significant in tending to confirm physiologic compatibility. Clinically, it is fortunate because it permits use for patients of all ages and sensibility without causing complaint.

Moderately rapid vasoconstriction follows its local application in appropriate cases. The ventilation is reasonably prolonged, depending, of course, on the type and degree of pathologic change.

No compensatory vasodilatation has been observed, no local reaction has been encountered. This is credited to the physiologic compatibility of the solution.

Side effects appear to come solely from errors in the vehicle. The commonest errors are hypotonicity and acidity and also occur in the use of antiseptics and oils.

General evidence of ephedrine drug action does not accompany intrasanal application performed correctly. Occurrence of general ephedrine effect is evidence of faulty technique, in that some of the solution has entered the pharynx and has been swallowed.

Nasosinal absorption alone is insufficient to give significant general effect, but absorption from the gastrointestinal tract is virtually complete.

Watkins¹⁷ thinks that antrostomy is a justifiable procedure. He states that the reasons for the bad repute in which antrostomy has fallen in the minds of both physicians and lay people are: 1. Operations performed in unsuitable cases; 2. unsuitable operations; 3. other nasal lesions which have been overlooked; 4. technical failures in operation.

A check-up on 22 cases of chronic sinusitis observed before and after Roentgen therapy caused Gatewood¹⁸ to question whether the results generally reported in the literature by Roentgenologists are not more apparent than real. Examinations consisted of the taking of histories, clinical inspection, investigation by shrinkage, suction and lavage, and comparison of films taken before and after treatment. There was no definite evidence of uniform improvement of the infection following Roentgen therapy in spite of X-ray changes. With the exception of a single case, microscopic examination of the polypoid contents of eight antra which had been subject to Roentgen therapy did not show any obvious difference from similar pathologic contents of other antra which had thus received slight treatment. Closer co-operation between the Roentgenologist, the rhinologist and the microscopist must be attained before determining the true effect of this therapy. It is essential that the rhinologist make the final examination in order to avoid erroneous conclusions.

It is apparent that the author considers X-ray therapy for any form of sinusitis to be only in an experimental stage.

Patterson¹⁹ discusses the treatment of nasal sinus infection by ultra-short wave diathermy. He states that the treatment of children by ultra-short wave is ideal in a great majority of cases. "We bring the child into the office daily and carefully shrink down the turbinates with a watery solution of ephedrine. We then carefully remove all the excess mucus and pus from the nose and apply the ultra short wave for about 15 minutes. After the first treatment the child, as a rule does not mind. Our experience has been that we get just as good, if not better, results by this method and we prefer it to lavaging the antrum, and we do not have half the fuss and trouble with the patients. The parents generally appreciate this also and as a rule have an aversion to having their child operated on. Ten or 12 treatments are usually quite sufficient."

Rusk, Dean, Jr., and Rindskopf²⁰ present a study of 55 patients with allergic rhinitis, with special reference to the results of potassium therapy in nasal allergy. They show that there was no alteration of significance in the blood serum potassium in any of the patients with nasal allergy. The sodium in the diet of their patients was reduced and they

were given 30 to 90 gr. a day of potassium chloride, or from 30 to 120 gr. a day of potassium gluconate. Thirty of the patients suffered from ragweed hay fever, and of these only three were relieved. Their work suggests that, in contrast to asthma and urticaria, in allergic rhinitis there is no systemic disturbance of the potassium balance.

Harsh and Donovan,²¹ reporting on a series of 40 cases, have failed to duplicate Abt's results — namely, they did not find sinusitis relieved by the administration of well diluted potassium chloride.

Miller²² states that the study of 43 cases of anterior ethmoiditis in infants under 2 years of age at the Children's Hospital in Philadelphia revealed that the most characteristic symptom was marked inflammation of the middle turbinate. The nasal mucosa was examined with a 5 mm. speculum on an electric otoscope.

He presents a photograph of a direct benzedrine insufflative apparatus for infants, through which treatment was given twice daily and, when necessary, nasal discharge was removed by mass suction with a hand bulb.

It was apparent that the treatments were beneficial in that they improved respiration. There was also a definite clinical impression that the course of the infection was shortened in most cases in proportion to the symptomatic relief of pain.

In the most severe acute infections it is not possible to prevent the development of otitis media, which sometimes occurred within a few hours after admission. The treatment failed in 20 per cent of the cases. There were no undesirable reactions.

Novak²³ reminds the reader that the attention of people in general has been called to the possible deleterious results from uncontrolled self-medication with nose drops. The intelligent public, which in these days is well informed about things medical, is keenly alert to the warnings that have been disseminated through the press and by radio regarding the indiscriminate use of oil in the nose. In view of the reactions to these warnings, Novak states that it may be well to examine the evidence critically to see how much is really known about some of the medicaments used intranasally.

He points out that there is ample clinical and experimental evidence to show that the mineral oils are profoundly irritating to the alveoli of the lungs, both in the experimental animal and in the human being. And he asks whether, in the light of experimental proof of the extreme toxicity of liquid petrolatum to the pulmonary tissues and the clinical evidence of damage to the lungs from such oil, if there is any justification for the use of oil in nasal therapy. He gives evidence that shows that the intranasal spraying of rabbits with liquid petrolatum produced desquamation of surface epithelium when continued for nine months. Then he makes the very sage observation that it would be faulty reasoning to conclude that, therefore, spraying the same oil into the human nose for a few days would have a deleterious effect on the surface epithelium.

To conclude that oil is a deleterious agent is illogical. Oil as a therapeutic agent is not used in normal noses. What of the nose in which there is no fluid mucus blanket, or the one with perverted glandular mucus secretion, or the one with abnormal ciliary activity? What experimental or clinical evidence is there that oil under these conditions is a deleterious therapeutic agent? In view of the fact that knowledge is so incomplete and fragmentary, a categorical statement that oil used in the nose is worthless, or even a deleterious therapeutic agent, is open to some question.

Pathologic conditions sometimes occur in which there is no vestige of normal physiologic function in the mucous membranes and as yet no experimental or other proof that oil is of no value, or that it is deleterious in its action in such cases has been presented. The fact that it is gratefully received by the patient may not be without importance.

Certain significant facts should not be lost sight of. One hundred six cases of oil aspiration pneumonia have been reported by 24 authors in the 10 years from 1925 to 1936. Among the laity, the use of oil drops for the nose is one of the three most common types of self-medication; the other two are the use of cathartics and of acetylsalicylic acid. This implies consumption of large amounts of oil by an enormous number of persons, and yet over a 10-year period there were only 106 reported cases of lipoid pneumonia.

We conclude that the use of any medicament in the nose except ephedrine in physiologic solution of sodium chloride is hazardous for some persons. No oil should be used in the noses of persons with lesions of the tongue, lesions of the pharynx, or hemiplegia or some other neurogenic disturbance. What applies to oil applies with equal force to practically all of the commonly employed drugs, whether in oily or aqueous vehicles. Furthermore, infants, debilitated children and the aged are more likely to aspirate liquids taken either into the nose or orally, and for these persons the use of liquid petrolatum or of any other kind of oil is clearly contraindicated. But the use of oil, when indicated, with care and judgment and in the rhinologist's office, may not be criticized, in view of the fact that legitimate differences of opinion exist regarding its therapeutic efficacy. It is, however, safer to use vegetable oils than mineral oils. Indiscriminate self-medication of various oils by the laity should be condemned.

In concluding an editorial on lipoid pneumonia,²⁴ the *Jour. A. M. A.* states: there is unanimity of opinion among investigators as to the dangers of intranasal medication with oils, particularly as is seen in the uncontrolled use by the public of the various preparations of liquid petrolatum. These dangers have been stressed in editorials in the *Journal*. The season of colds is now at hand and the incessant bombardment over the radio extolling certain preparations for intranasal medication — justify reiteration.

Parkinson²⁵ writes that the above editorial on lipoid pneumonia is timely and forceful but that in his opinion far short of its potential value by reason of two serious omissions. Proof has been given in a report of September, 1938, that the so-called mild silver proteins, argyrol and neosilvol, provoke pulmonary tissue reaction with consequent damage to the lung tissue similar to that produced by liquid petrolatum. These products are still in common although diminishing use by the profession and public alike.

Also having pointed to the wrong road, had you indicated the right one you would have added utility to enlightenment. Thus, the same investigators demonstrated that isotonic saline solution of ephedrine and related nasal substances caused no reaction in pulmonary tissue. This coincides with previous

studies on their relation to nasal and sinal epithelium. The investigators, therefore, advocate these solutions as the medications of choice for local nasal treatment.

The modern trend is towards a physiologic approach to rhinological problems. This is a sound but revolutionary change and a specialty in which ingenuity has been notably abundant.

My feeling is that failure to make correction will not be missed by the manufacturers of the mild silver nostrums whose advertising is always with us.

NASAL ALLERGY.

Hansel and Chang²⁶ state that in the management of frequent cold, sinusitis, bronchitis and recurrent pneumonia, the possibility of allergy as an etiologic factor must always be considered. Allergy may stimulate many of the symptoms and signs of acute or chronic respiratory infection. They reprint a table depicting the differential points of allergic and infectious conditions as reported by Cohen and Rudolph.

Of 200 children considered as a routine for removal of the tonsils and adenoids because of these complaints, definite diagnosis of nasal allergy was established in 26, or 13 per cent. It is significant that six of these patients had hay fever. These cases of respiratory allergy may be overlooked unless an adequate history, physical examination and cytologic studies of the nasal secretions are carried out in each instance. Removal of the tonsils and adenoids in allergic children should not be performed during hay fever season, and the indications for operation should be the same as in nonallergic children. Tonsils and adenoids should not be removed with the idea of alleviating allergic symptoms.

In the queries section of the *Jour. A. M. A.*²⁷ for May 4, 1940, N. B. asks — Am I correct in assuming that in severe vasomotor rhinitis at childhood the hope for immediate relief is poor, whereas the hope for eventual relief as the child grows older is rather bright, with or without treatment?

The *Jour. A. M. A.* answers — It is assumed by vasomotor rhinitis the inquirer has in mind the perennial type of the allergic nasal condition. Most authorities do not agree with

the assumption expressed here that the hope for relief is poor, especially in children. However, these patients usually require careful study, not alone from the allergic point of

**DIFFERENTIAL DIAGNOSIS OF ALLERGIC AND INFECTIOUS
CONDITIONS OF THE UPPER RESPIRATORY TRACT
IN CHILDREN.**

HISTORY.

ALLERGIC.

1. Attacks usually recurrent.
2. Often mild symptoms between attacks.
3. Definite relation to heredity.
4. Not contagious.
5. Not related to exposure to another case.
6. Constitutional symptoms slight.
7. Foods and inhaled substances often traced as causes.
8. Itching common.
9. Wheezing common.
10. Other allergic conditions present or in past history.

INFECTIOUS.

1. Attacks usually single.
2. Usually clears up completely.
3. No relation to heredity.
4. Contagious.
5. Definite relation to exposure to another case.
6. Constitutional symptoms more marked.
7. No relation to foods or inhaled substances as cause.
8. No itching.
9. No wheezing.
10. Usually no other allergic conditions present or in past history.

EXAMINATION.

ALLERGIC.

1. Visible mucous membranes, pale, glistening, edematous.
2. Thin, watery, mucoid nasal discharge; mucous sputum.
3. Smear shows eosinophiles in large numbers.
4. Other signs of allergy often present.
5. Sinus involvement of edematous type.
6. Wheezing breath sounds.
7. Roentgenogram shows bronchial markings increased.
8. Allergic skin reactions usually positive.

INFECTIOUS.

1. Visible mucous membranes hyperemic, red.
2. Mucopurulent or purulent nasal discharge or sputum.
3. Smear shows polymorphonuclear neutrophils as predominant, cell eosinophils few or absent.
4. No other signs of allergy.
5. Sinus involvement of purulent type.
6. No wheezing breath sounds.
7. Bronchial markings not increased in Roentgenograms.
8. Allergic skin reactions usually negative.

TREATMENT.

ALLERGIC.

1. Epinephrine specific for asthmatic symptoms.
2. Avoidance of specific allergens followed by relief.

INFECTIOUS.

1. No relief from epinephrine or ephedrine.
2. Avoidance of food or inhalant substances produces no change.

view but often from the point of view of the local nasal condition. Frequently the symptoms, while based primarily on a definite atopy, may be aggravated by the presence of a local nasal pathological condition such as polyposis, fibroma of the nose or sinusitis. The allergic study in itself must be complete and not limited to cutaneous tests. Frequently, observation for many months, with repeated questioning, may be necessary to evaluate the various etiological factors even in cases in which the cutaneous reactions are positive. Unfortunately, too many patients are referred to the specialist in allergy with the request for cutaneous tests as the sole diagnostic procedure. A carefully taken history may give the experienced physician clues to the causative factors, which in many cases are confirmed by positive cutaneous reactions. There are a large number of patients who have negative reactions. The diagnostic procedures must then be supplemented by careful environmental and diabetic studies. Instructions for making such studies are available in any of the recent works on allergy.

The frequency of relief varies from 50 to 70 per cent according to reports of most workers. Kahn found that of 720 cases with nasal allergy, 40.7 per cent were sensitive to inhalants, 5 per cent to food, and 54.3 per cent to inhalants and contact substances. Of these 720 patients, 47 per cent were satisfactorily relieved by allergic management alone, 27 per cent by allergic management plus conservative local nasal therapy, and 21.7 per cent by allergic therapy plus nasal operation, while only 3.5 per cent failed to get relief. Such a result, as Vaughan states, is an indication of the value of combining adequate allergic and adequate nose and throat therapy.

As to waiting for a child to outgrow the condition, this occurs spontaneously in 5 per cent of all the allergic cases. On the other hand, asthma follows nasal allergy in about 40 per cent of the cases. It is, therefore, unwarranted optimism to expect a spontaneous cure in a large proportion of cases.

No disease demands a more all-round attack than asthma, yet no disease has been more regarded as the province of various specialties. Some have concentrated all their attention on the nose and its annexes, others have found the com-

plete explanation in allergy, and yet others have regarded the psychological aspect as all-important. It is a particular merit of the late Dr. James Adam's²⁸ "Asthma and the General Practitioner" that he does take an all-round view of the problem, which indeed characterized his earlier more elaborate book on the subject.

He naturally has his own predilection; thus, he considers that allergy has been worked for considerably more than it is worth; he regards the psychological factor as chiefly the result of early coddling, especially in the only child, and fears adrenalin addiction. On the other hand, he attributes a good deal more to what may be broadly called alimentary toxemia than do most.

In general, his view is that the alimentary factors may also be treated to ill-split proteins resulting either from inadequate gastric secretion or from overcrowding the diet with carbohydrates. He divides asthmatics into three groups—the first, nonallergic, who respond best to general treatment; the second, who are sensitive to some foods; and the third, who are sensitive to inhalants. He regards the skin test as unreliable for the second group, but of real help for the third. The whole book is eminently practical and, as the outcome of wide personal experience, should be very helpful to the general practitioner.

Hall²⁹ states that only within recent years has any serious attention been paid to the association between nervous factors and bronchial asthma. Hurst, in 1929, thought that the most common psychological factor in asthma was expectation of an attack in certain places and under certain conditions, and attributed the fact that some 75 per cent of patients are relieved directly they enter a hospital through the expectation of benefit from the treatment they are about to receive. In relation to this, he stresses the importance of instilling into asthmatics a spirit of optimism as regards to the ultimate outcome of their case. Rogerson, Hardcastle and Duguid, in 1935, remarked upon the occurrence of asthma in overprotected children and regarded the benefit derived from convalescent treatment as being attributable to the removal of the child from the difficult home environment. Perason, in 1938, stressed the frequency with which overanxiety, timidity

and lack of self-confidence are encountered as character traits of asthmatic children, and the necessity for treating these and the environmental circumstances contributing to them.

Hall presents five cases of asthma in childhood which have the following characteristics in common:

1. Asthma was the principal symptom for which advice was sought.
2. The symptom had been present for at least three years.
3. The patient was incapacitated by the attack—in one case with respect to ability to follow an occupation—in four cases concerning ability to attend school with any degree of regularity, and, in all, as regards ability to enjoy the normal physical and pleasurable activities of childhood.

A history of family or previous personal allergy was obtained in each of the five cases described. In four of the five cases quoted there was a history of recurrent coughs and colds, and in three of these a bronchitic attack immediately before the first attack of asthma.

The treatment adopted in detail consisted essentially of advice and reassurance. No other form of treatment was employed during the time that the cases were under observation, the use of drugs even during the asthmatic attacks being discouraged.

ANATOMY.

Mangiaracina³⁰ reports a case of congenital atresia of the posterior nares in which operation was performed and patency achieved.

M. T., age 11 years, presented herself with a history of nasal obstruction and nasal discharge since birth. A septal deviation almost completely occluded the left nasal chamber. The nose was full of mucoid secretion. An applicator placed in each side of the nose failed to enter the nasopharynx.

Operation was performed through the submucous resection route, removing the vomer to the posterior edge. This revealed that the posterior openings were closed by a thick fibrous membrane. The fibrous wall was removed from its

attachment. An incision was then made through the elevated mucoperiosteum on each side of the septum near the posterior extremity. A large opening resulted. A tampon was placed in the postnasal space. The new opening was packed with petrolated gauze. The next day the nasal strip and postnasal tampon were removed. The packing in the new opening was left in two days longer and then removed. Recovery was uneventful. Six months after operation, a finger cot containing a strip of plain packing impregnated with iodized oil was placed in the nose and made to project into the nasopharynx. The Roentgenograms taken before and after operation accompany the article and demonstrate the satisfactory results.

Cinelli³¹ briefly but clearly reviews atresia of the anterior nares — choanal atresia — and atresia of the nasopharynx.

An editorial³² in the *Brit. Med. Jour.*, on new light on poliomyelitis from Australia, states: E. Graeme Robertson (*Med. Jour., Australia*, 1:156, 1940) had already reported that he had failed to detect any abnormality in the olfactory bulbs of 10 out of 11 patients who had died in the acute phase of the disease. This observation casts doubt upon the generally accepted view, based on experiments with the comparatively unsusceptible rhesus monkey, that infection usually enters by the olfactory bulbs in human beings. In the opinion of Dr. F. M. Burnet (*Med. Jour., Australia*, 1:325, 1940), the hypothesis might well be dropped if positive evidence could be obtained of other portals of entry. The frequency with which the virus has been found in tonsils, from nasopharyngeal washings and in feces points to other channels of invasion.

FOREIGN BODIES.

Golden³³ reports an air rifle buckshot in the left posterior ethmoid sinus of a white school boy, age 13 years. It was removed by intranasal ethmoidectomy. The results were satisfactory. Although the left eyeball showed definite signs of injury, the patient had perfect vision in that eye one month after the injury. A survey of the literature shows very few reports of foreign bodies in the paranasal sinuses and none of a foreign body in the ethmoid sinus removed by operative intervention.

PHARMACOLOGY.

Bryant²⁴ calls attention to the fact that despite the warnings that have appeared occasionally in the literature, many otologists still deny the danger of the production of generalized argyria from the use of silver-containing intranasal medication. This heedless attitude is abetted by the advertisements of certain manufacturers of such medications. One of them states quite consistently in the advertising pages of medical publications that the solution is "nontoxic, definitely bacterial static and, above all, it is markedly soothing to inflamed tissues."

He shows that the generalized pigmentation of argyria is permanent therefore, its only reasonable treatment is prevention. Generalized argyria is apt to result from the photochemical action of light when the body carries silver equal to 8 gm. of silver arsphenamine. Silver in the usual intranasal medication is absorbed by the nasal membranes and distributed throughout the body. Absorption of silver is experimentally demonstrable after six weeks of regular medication and in some instances after four weeks. In this study its presence was proved by microscopic examination of the nasal tissues and by biospectrometric examination of several of the internal organs. Widespread generalized deposits of silver were demonstrated throughout the tissues of the lungs of an experimental animal, aside from bronchopneumonia lesions as the result of the use of intranasal medications containing silver.

He concludes that the use of silver-containing nasal medications (argyrol and neosilvol) over even a few weeks is dangerous and accomplishes nothing that cannot be accomplished safely and more efficiently by other means. Measures should be taken to see that the public is warned of the danger of the production of argyria by long-continued self-medication with silver preparations. All such preparations intended for use on mucous membranes should carry a warning statement on their labels. This gives one cause to think of the pulmonary lesions occurring especially in infants and children who have had nose drops of this type for a preceding cold in the head.

In the discussion which follows this paper, Dr. Gordon S. Harkness states that many families include silver prepara-

tions in the family medical cabinet but are unaware of the dire consequences from prolonged self-medication, and states that for a long time in his practice his associates and himself have had "nonrefillable" on every such prescription.

The increased popularity of silver compounds as ophthalmic disinfectants has caused an increase in argyria of the eye. Hill and Pillsbury³³ have collected reports of 60 cases of this condition; silver nitrate was responsible for about two-thirds of the cases. Their monograph concludes with a bibliography of 600 references.

Lawton³⁰ and the late Ellison L. Ross have continued their experiment to yield information regarding the absorption of material from the nasal mucosa, the sites to which the material will pass, and the route it will follow. They have proven that mercurochrome introduced into the nose and retained there during life will pass through the mucosa of the nose and sinuses, through the turbinates, through the bony walls of the frontal sinus anteriorly, superiorly and posteriorly, and even through the dura, to discolor the cortex of the brain in this area in much less than two hours. This transmission is mostly by diffusion, as is known by the rather general concentric spread through all of the paranasal tissues, though the process occurred to an appreciable extent only in the living animal.

The influence of the removal of tonsils and adenoids on the upper respiratory and other diseases of childhood was discussed by the Section on Laryngology of the Royal Society of Medicine.³⁷ Sir L. Barrington Ward said that medicine and surgery suffered from changing fashion, and tonsillectomy had not escaped its influence. Possibly 10 years ago tonsils were removed for inadequate reasons. The peak year was 1930 when at Great Ormond Street 7,430 such operations were performed; the figure for 1938 was 2,729. An antitonsil faction has developed in almost religious fervor. He made the statement that if adenoids only were removed and septic tonsils left behind, adenoids were very likely to grow again, and that chronic enlargement of the glands of the neck was indicative of tonsillar infection.

There was some evidence that rheumatism was less likely to attack individuals who had undergone tonsillectomy, but

the influence of the tonsils in precipitating a relapse was even more striking and more easily proved. Another indirect indication was chronic septic poisoning affecting various systems. It was not uncommon in the Outpatient Department to see a flabby child with scoliosis, knock-knee, talipes valgus or similar conditions, suffering from a chronic infection of the tonsils, and the first thing to be done was the elimination of the toxemia.

Kershaw said that the school medical officer had certain advantages in observation, being able to see the failures of other people and compelled to see his own. He began by assuming that the presence of a condition which was constantly relieved by operation could be regarded as an adequate indication for the performance of that operation, and on investigating the after-histories of several hundred cases of tonsillectomy he obtained an indication that such conditions as recurrent sore throat and prolonged otitis media were improved by operation in the large majority.

On investigating the question of the size of the tonsil, he came across something that was rather new to him. Out of 1,000 children who had been reported as having enlarged tonsils at the school medical examination, he found that less than 10 per cent had developed symptoms subsequent to the first discovery of the tonsillar enlargement; also, that with increasing age there was an unmistakable tendency for the tonsil to diminish.

With regard to rheumatism, the results were inconclusive. Children seemed as liable to develop rheumatic symptoms after tonsillectomy as before.

A child's admission to school was apt to be followed after about six months by enlargement of the tonsils, frequent colds, possibly chronic catarrh, recurrent sore throat and other infections commonly associated with septic tonsils. These conditions lasted for from one to two years, varying with the home circumstances and state of nutrition, and in 75 or 80 per cent of cases cleared up quite spontaneously and quickly. It appeared, therefore, that his condition depended not upon any particular age factor but upon the child's first exposure to the common nasopharyngeal infections of childhood. That the response of the tonsils was presumably protective and that the process which completes itself in from

18 months to two years was to a certain extent an immunizing one. If the enlargement of the tonsils, therefore, was secondary and protective, it behooves one to look rather more cautiously into the indications commonly given for removal.

Rodgers believed that there was only one indication for tonsillectomy; namely, repeated attacks of tonsillitis from which the patient did not recover completely in the interval and which was unrelieved by other forms of treatment. Size alone might be an indication but the tonsils could be very large without causing disability. When adenoids were found, there was one single indication for removal; namely, nasal obstruction which would not yield to conservative measures. He believed adenoids could be a result and never a cause of infection.

Collier pleaded for the abolition of the term enlargement of the tonsils and adenoid. The amount of total tissue was of no importance without reference to the size of the nasopharynx — the Basque children, age from 5 to 15 years, were found to have tonsils as large as or larger than walnuts, but on their disbursement to various parts of this country their state of health compared favorably with that of the English children among whom they were placed. The conclusion she reached was the need for a more widespread recognition of the fact that removal of tonsil and adenoids was not a panacea for all the ills of childhood. Each person should be judged on the relation between the tonsillar conditions and the symptoms.

Kershaw replied on the point concerning the age at which tonsillectomy should be done. He agreed that cases of emergency might arise at any age, but he suggested that ordinarily cases should never be subjected to operation until the period of immunological enlargement had arrived — the first two or three years of school life. With regard to septic foci he could not avoid the cynical reflection that sometimes the removal of tonsils was due less to the fact that they were a septic factor in that particular case than to the fact that they were the most accessible of all possible factors.

ATROPHIC RHINITIS AND OZENA.

Halasz³⁸ believes destruction or misdevelopment of the lymphatic tonsillar ring is the primary cause of ozena. He first

describes microscopical studies of ozena which show inflammation and atrophy of the mucosa. He then discusses the pathogenesis of these conditions. Inflammation of the mucosa results from the lower resistance to bacteria brought on by stasis. The atrophy results from trophoneurotic influences. The fundamental cause of these conditions he traces to impairment of tonsillar endocrine function. Ozenous subjects are likely to have atrophic tonsils, which condition he believes to be due to original hypoplasia. The author maintains that impaired secretion of some biohormonal specific damages the mucous membrane of the upper respiratory tract, accounting for the exclusive appearance of ozena in this region.

He expresses his main thesis thus: "Hypoplasia of the tonsils and the adenoid tissue diminishes hormonal output, and lack of hormone becomes manifest as ozena." However, if there is no disposition to the development of ozena, lack of tonsillar hormone will not produce it.

The author next discusses the nature of the tonsillar hormone. He finds it to be vasoregulatory in function, cholinergic in effect, and that it produces vasodilatatory stimulation of the nasal mucosa with perfect healing of the ozenous condition. Several choline-ergic properties have been demonstrated in tonsillar extracts, accounted for by the identification of acetylcholine as the active principle. Acetylcholine undergoes decomposition by a choline-esterase. By the inhibition of the action of choline-esterase obtained through the injection of physostigmine and potassium into the tonsil, the author was able to prove that ozenous tonsils produce acetylcholine in sufficient amounts but that this is decomposed by esterase before it is able to become effective.

Finally, he points out that successful treatment of ozena has been achieved by means of intratonsillar injections of potassium and physostigmine, which inhibit the action of choline-esterase.

The Council on Pharmacy and Chemistry and the *Jour. A. M. A.*³⁹ have repeatedly warned against the indiscriminate and prolonged use of estrogen and have emphasized the possible occurrence of mammary carcinoma in patients who are susceptible to the development of such malignant growths. It would be unwise to consider that there is safety in using

small doses of estrogen since it is quite possible that the same harm may be obtained through the use of small doses of estrogen if they are maintained over a long period.

Reports which have appeared are quite appropriate at the present time as new potent estrogens, easily administered, are being prepared for therapeutic purposes.

It is hoped that it will not be necessary for the appearance of numerous reports of estrogen-induced cancer to convince physicians that they should be exceedingly cautious in the administration of estrogens, which, used correctly, are apparently valuable therapeutic agents.

SURGERY.

Plastic surgery of the external nose during recent years has been greatly improved. This is particularly true in corrective operations upon the nasal bones, the lateral cartilages and the septum. Surgical correction of the tip of the nose is more difficult. It is, however, essential, for deformities of the nasal tip are the most conspicuous of all nasal deformities.

In a consideration of the anatomy and development of the nasal tip, Converse¹⁰ states that during early childhood the external nose is very different in shape from the adult nose. It is flat and smaller in proportion to the dimensions of the face and the adult nose. The alar cartilages are extremely small. For this reason it is essential that in cases of harelip which present an asymmetry of the nasal tip due to a disproportion of the alar cartilages, no correction be attempted until the nose is fully developed.

Around the age of 6 years the alar cartilages are well defined small structures and can be outlined under the mucosa of the nose by retracting the alar and palpating its intranasal surface with a small probe. At puberty the whole of the external nose increases rapidly in size along with the septum. At this time the alar cartilages begin to assume their definitive state and proportion.

He describes two methods by which adequate exposure of the nasal tip can be obtained. Both methods avoid any disturbance of the physiology of the nose. The muscles, nerve and vascular supply are undamaged. The mucous membrane

is intact. Injury to the muscles or their nerve supply would result in an expressionless nose. Following such an operation the patient should be able to dilate the nostrils and to elevate the tip. Destruction of mucous membrane would result in disastrous nasal stenosis. All incisions should be carefully sutured with fine silk so as to obtain rapid healing and minimum of scarring. The article is well illustrated.

CASE REPORTS AND TUMORS.

Nasomaxillary luposyphilitic hydridism is the probable diagnosis of a case described by Saibene and reviewed as follows in the *Archives of Otology*.⁴¹

The patient described by Saibene was a girl, age 12 years, who had a destructive, ulcerating lesion located in the nasal vestibule and involving the bone of the septum and the maxilla. The preliminary diagnosis was lupus. Appropriate treatment being ineffectual, the presence of syphilis was suspected, and a Wassermann test gave positive results. Antisyphilitic medication caused prompt and rapid recovery.

The author discusses the etiologic diagnosis at length. In favor of lupus were the hypertrophic vegetable character of the ulceration, with rosy gray nodules, and the discovery in the biopsy material of tuberculous granuloma and acid-fast bacilli. The deep-seated involvement of the bone and the prompt improvement following antisyphilitic treatment indicated syphilitic participation. The failure of the patient to react to the tuberculin test does not invalidate the diagnosis of lupus, since it has been shown by Tarentelli and others that anergia to tuberculin may be present in patients with late syphilitic manifestations and a strongly positive Wassermann reaction. The improvement in the tuberculous element in the lesion, along with the syphilitic component, is explained by increase in the general bodily resistance, induced by the antisyphilitic treatment.

Smith⁴² in a paper on osseous lesions of the nose and sinuses gives case histories with photographs, X-rays and sections of a boy, age 14 years, and a girl, age 16 years, who had bony tumors which were removed from sinuses. The interesting point is that, although clinically and grossly the masses were diagnosed as tumors, it was impossible to classify them as neoplasms histopathologically.

In a study of the hypertrophic changes and tumor formations in bone lesions of the nose and sinuses, he finds that in contrast to the well established growth and clinical features of the lesions, there is a great deal of uncertainty as to the pathologic interpretation. The majority are treated as osteomas and are thought of as neoplasms.

Osteoma as a true neoplasm has not been clearly distinguished from other forms of overgrowth of bone. It appears to be pathologically related to the so-called fibrocystic group of bone lesions. Because of the number of instances in which one finds that it combines the clinical features and histologic characteristics of both giant cell tumors and osteitis fibrosis, one feels that they may be closely allied and the possibility of a common cause must be considered. Some form of trauma seems to be the most important etiologic factor. Some other metabolic or nutritional disturbance may be necessary to account for such an abnormal reaction, and further clinical and histological investigation should be carried out to establish the basic nature of these processes. A better understanding of the etiologic factors may reveal that in the cases in which the lesion cannot be definitely proved to be a true neoplasm, radical surgical intervention with the attendant deformity, in an attempt to eliminate the condition, is not necessary.

Brunner⁴³ presents the case report of a white female child, age 12 years, whose right eye was displaced outwards by a fibromyoma in the right ethmoid.

First signs were three and one-half years prior to admission for operation. The original symptoms were itching and sneezing in the right side of the nose. This became progressively worse and in the meantime a swelling began to appear on the right side of the nose above the right inner canthus, which had become progressively worse and slightly tender. In the past few months she had had frequent nose bleeding from the right side.

On her admission, the right eye was slightly bulged outwards and displaced laterally. The movements of the eye were normal. There was no chemosis and the skin of the lids was white. The distance between the right inner canthus and the midline was about twice as large as the distance between the

left inner canthus and the midline. This finding was explained by the fact that the right nasal bone and the right frontal process of the maxillary bone were situated about in the frontal plane. Hence, the back of the nose seemed to be enlarged. There was no dehiscence of the bones on the right side of the nose. No crepitus could be felt.

In the right side of the nose there was a large fungating mass involving the middle turbinate. Breathing was blocked. Transillumination showed darkness of the right frontal sinus and the right antrum. The glands were not increased, and the ears were normal.

Biopsy of growth in the right side of the nose was taken. Moderate bleeding occurred. X-ray examination showed increased density over the right frontal sinus, ethmoid and maxillary sinuses, suggestive of a sinusitis. There was also increased density over the upper part of the right nasal cavity with apparent displacement of the septum towards the left and sharp line of demarcation projecting into the right orbit.

[A photograph of the patient is shown, but too much from the side to give the reader as good a picture as obtained from the description. The X-ray is not reproduced. Good photographs of sections of the growth are provided.—ED.]

Operation was performed under general anesthetic. An incision was made in the region of the right ethmoid. The tear sac was pushed laterally out of the way. The nasal bone and the frontal process were bulged out and very thin. An opening into the nasal bone was made and the tumor was bulging through the wound. The tumor was covered with mucous membrane. The opening into the bone was enlarged. The periorbit was pushed aside, bringing into view the whole lamina papyracea, which was replaced by the tumor, which bulged into the orbit but did not invade the periorbit. The mucous membrane covering the tumor was incised and an attempt was made to enucleate the tumor submucously. Since the tumor filled up the whole ethmoid capsule, it was only possible to remove the tumor from the lateral wall of the ethmoid. On the mesial wall of the ethmoid and on the ethmoid roof the tumor had grown together with the mucous membrane. At these places it was necessary to remove the

growth by sharp dissection. The tumor in itself was friable and could only be removed in pieces. The tumor was not vascular, despite the fact that there was intensive bleeding, due to passive hyperemia of the mucous membrane covering the tumor. After removal of the tumor there was a large funnel-shaped cavity which was bordered laterally by the intact peri-orbit and the remains of the mucous membrane, upwards by the roof of the ethmoid, mesial by the rough mucous membrane of the mesial wall of the ethmoid capsule, downwards by the floor of the ethmoid capsule. The tip of the funnel-like cavity lies near the optic foramen. The wound was partially closed. Uneventful recovery.

The child, five months later, was in good health and had gained weight. There was a fistula as large as a pea perforating the frontal process of the maxillary bone and penetrating into the nose through the agar nasi. The mucous membrane of the right middle turbinate was red and swollen, but there was no pus within the middle meatus. No signs of tumor were present.

There is a long discussion of the histopathology, culminating in a final diagnosis of fibromyoma with extensive hyaline transformation.

In a clinic of 840,000 patients, Handousa⁴⁴ discovered records of 18 osteomata; 14 fibromata, mostly nasal pharyngeal; two angioma; two papillomata, and one reticuloma.

Two of the cases presented were children. The first was a male, age 14 years, who was under investigation for the cause of chronic cough. X-ray of the sinuses revealed an osteoma in relation to the right frontal sinus — exploration was refused and the patient was not seen again.

The second child was a young girl, age 12 years, who saw the author on account of the swelling on the left side of the face, noticeable for five months. There was no history of trauma, pain epistaxis or nasal discharge. Examination revealed a bony, hard swelling in the region of the left canine fossa, not tender. The skin was freely movable over it. No abnormality was detected in the nasal fossae or face. The X-ray is credited with showing a cancerous osteoma in the region of the left antrum of Highmore. Operation was per-

formed. Tumor was not separable from the lower part of the anterior walls of the left maxillary sinus. The other walls were free and covered with intact pale mucosa, which was slightly thicker than the normal. The antral cavity was greatly reduced and it was free of discharge. The histopathological dissection showed that the structure was compatible with osteoma.

S. A. Friedberg⁴⁵ reports three cases of nasopharyngeal fibroma (two of which were in children) in which treatment by a combination of irradiation and surgical diathermy has been successful.

An attempt was made to analyze the histologic alteration resulting from irradiation in these cases. In two, definite changes could not be observed in sections of the tissue removed for study before and after treatment. Because of the attachment of the tumor to the bones of the base of the skull and the involvement of these bones by pressure necrosis, it is suggested that avulsion with the cold snare should be abandoned. The combination of irradiation and surgical diathermy offers a safe and effective method of treatment for vascular fibroma of the nasopharynx.

Otty⁴⁶ reports a nasopharyngeal fibroma in a male patient, age 14 years. There was a thick red mass on the floor of the right nasal cavity. Palpation of the nasopharynx revealed a mass which might be adenoid but was rather firm. Eight days later, biopsy performed and provisional diagnosis made of edematous fibroma. Two months later, this mass was removed from the nasopharynx and right nasal cavity. It was found attached to the nasopharyngeal roof far forward. *Pathological Report:* Angiomatous fibroma, edematous in part. Eight months later, patient reported again because of nasal obstruction. Smooth swelling was noted above the right inferior turbinate, pushing the septum over to the left. Only partial nasal obstruction. No epistaxis. Patient was seen at intervals of three months for the next two and one-half years, when it was noted that the nasal swelling was much larger and the nasopharyngeal swelling extended to the left of the midline.

Sodium morrhuate was injected at intervals of 10 days or so. And four months later the patient thought he could

breathe through the right nostril at times. The injection was then continued at monthly intervals. Five years later, there was still a fair-sized mass in the nasopharynx but there was a fair nasal airway.

This case was really of interest from the point of view of the use of sodium morrhuate. The treatment had been used over a period of 18 months at intervals of three weeks or so. One cubic centimetre sodium morrhuate was injected into the tumor, and to the patient's delight it produced a local sloughing until the result was obtained. The patient now had quite a fair nasal airway and, although there was still a tumor, Otty hopes that it would now disappear, as those tumors were supposed to do at puberty.

Stimson⁴⁷ reports a case of epidermoid carcinoma of the nasopharynx occurring in a young boy, J. W., age 10 years, white, male, was admitted to hospital, July 3, 1937, having complained five months previously of a sore throat, which persisted for four months, at which time a swelling appeared in the left side of the neck. There was occasional fever and expectoration of blood, with intermittent headaches. Tuber-culin test done at that time was negative. A tonsillectomy was performed without improvement.

Examination on admission was negative except that all the glands on the left side of the neck were greatly enlarged, firm and only slightly tender. No redness or increased heat; the glands were movable. The eye reflex in pupils was normal. The throat was normal.

Pathological report on a biopsy on the glands of the neck was undifferentiated metastatic carcinoma. X-ray of the skull, cervical spine and lungs failed to reveal any metastasis.

Under general anesthetic an examination of the nasopharynx revealed a raised indurated mass in the left nasopharynx which bled freely. The report on the specimen taken was transitional cell epithelioma.

He was given 19 consecutive daily treatments of 200 r. X-ray therapy, the exposure being varied over the right and left sides of the face to include the nasopharynx and neck. He finally died 11 months after admission.

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CHEMOTHERAPY OF TUBERCULOUS OTITIS MEDIA.*†

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Many years ago chemistry and medicine were one and the same thing. Later on, scientific medicine drifted away from chemistry. However, with the discovery and the use of sulfanilamide, sulfapyridine and sulfathiazole, chemistry has again assumed a very important place in the practice of scientific medicine. Willard¹ said at the last meeting of the Association of American Medical Colleges that "during the last 25 years the close association between chemistry and medicine has again been rapidly developing. During that period, the assistance which chemistry has rendered to medicine is one of the outstanding developments in science."

Some investigators have shown that sulfanilamide and sulfathiazole have very little, if any, effect on tuberculosis. Sulfapyridine does some good in lessening the severity of the disease. We have, therefore, used sulfapyridine to the exclusion of other drugs for our experimental work.

On the other hand, Ballon, Guernon and Simon² have shown definite improvement in guinea pigs treated with sulfanilamide after the animals had been experimentally infected with tubercle bacilli. They treated 72 animals and kept 51 as controls. They did not administer sulfanilamide until after the pigs were infected. They obtained just as good results by starting the treatment from three to 10 days after inoculation, but not if they waited 16 days or more. They show the difference in the pathology of the spleen, lymph nodes and local lesions of the treated and untreated animals. The difference in the organs is quite marked. The inhibitory effect

*Read at the Seventy-fourth Annual Meeting of the American Otological Society, Inc., Atlantic City, May 26, 1941.

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Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, June 29, 1941.

was obtained, even though treatment was interrupted at intervals. The sulfanilamide was administered by mouth. They regarded as an adequate daily dose for the entire treatment period, 0.70 to 0.75 gm. per kg. of body weight. They believe some of the poor results reported by others are due, in part at least, to inadequate dosage.

Feldman and Hinshaw³ administered sulfapyridine to guinea pigs before the pigs were inoculated with tubercle bacilli, and they continued the administration of the drug after inoculation. They found that sulfapyridine exerted a definite and striking modification and retardation of the expected course of the experimental tuberculosis in guinea pigs. However, we have given sulfapyridine only after the animals have been experimentally infected with human tubercle bacilli, except a group of guinea pigs with experimental skin lesions. These animals were pretreated. Eighty per cent of the pretreated animals lived much longer than the controls. These have not been reported.

Flippin, Forrester and Fitz-Hugh⁴ treated experimentally infected guinea pigs with sulfapyridine. They started the treatment a few hours after the pigs were inoculated and continued the treatment for only 10 days. They found very little difference in the spleens of the treated animals and the controls. Ten days is a very short time to treat tuberculosis. They mention the improvement obtained in the treatment of pneumonia in patients with pulmonary tuberculosis.

Giroux⁵ found that the guinea pigs treated with sulphonamides after the animals had been experimentally infected with human tubercle bacilli lived over four months longer than the untreated controls.

Feldman, Hinshaw and Moses,^{6,7} in October, 1940, and in March, 1941, reported favorable results from the use of Promin for the treatment of experimental tuberculosis. We have not used Promin to date.

We (Spencer, Whitehead and Duffner⁸) reported the results of our work with guinea pigs at the Academy meeting in Cleveland last October. Guinea pigs experimentally infected with tubercle bacilli, taken from human sputum, and then treated with sulfapyridine, after the disease had had time to develop, fared better than the untreated controls.

The dose of sulfapyridine which we used was that recommended by Birkhaug,⁹ which is 0.2 gm. per kg. of body weight. We used the pure crystalline form of sulfapyridine obtained from Merck and Co. We are indebted to them for a generous supply of the drug. This dose is within the range used for clinical therapy and is the dose recommended for clinical use.

This present report deals with rabbits after the middle ears had been experimentally infected with human tubercle bacilli obtained from human sputum. None of the animals received any sulfapyridine until after the ears had been experimentally infected. We used the method of Corper, Damerow and Cohn¹⁰ for preparing the emulsion of tubercle bacilli, which is as follows:

"The cultures used in these experiments were made from a human sputum isolated strain. The strain was of such a virulence that 0.000,010 mg. of the moist growth would cause the death of a guine pig in three months. The bacilli used in this work were grown on Petroff's media, and in each experiment the culture was three weeks old when used. The inoculating procedure used is the one developed and used by Corper, Damerow and Cohn¹⁰ at the National Jewish Hospital for Consumptives in Denver. It is as follows: 10 mg. of the moist growth from the culture tube is carefully weighed in a centrifuge tube. This is then ground against the side of the tube, using a glass rod. While doing this, several drops of a 0.5 per cent sodium taurocholate solution are added to facilitate the grinding of the colonies. After this is complete, the suspension is made with 0.9 per cent Na Cl solution. Successive dilutions are then made until the desired strength is obtained."

Eight young albino rabbits were inoculated with 0.4 mg. of virulent tubercle bacilli, suspended in 0.4 cc. of normal saline. The inoculations were made into the middle ear cavity on both sides. The membrana tympani was visualized, through a speculum, with the aid of a head mirror. When the gray drum was clearly seen, the needle was introduced through the drum into the middle ear cavity. The needle used was the straight type used for injecting a local anesthetic about the tonsil.

Two days later, treatment with sulfapyridine was instituted in four of the rabbits. The other four rabbits were used as the untreated controls.

For the first eight days the treatment was continuous. Each treated animal was given 0.2 gm. of sulfapyridine per kg. of body weight, twice each day by mouth, in gelatin capsules. This procedure resulted in a great deal of trauma to the rabbits' mouths from forcing them open. For this reason the treatment was suspended for two days and then continued with an intravenous sodium sulfapyridine solution. This solution was made with distilled water, so that each cubic centimetre contained 0.2 gm. Each treated rabbit was given 1 cc. of the solution per kg. of body weight twice a day. The injections of the drug were made in the marginal veins of the ears. Since the sodium sulfapyridine solution was rather caustic, a thorough thrombosis of the veins of the ears resulted in three weeks, making further treatment by this method impossible. Five days later, the animals were sacrificed.

The skin was removed from the entire head of each of the eight animals and the mandibles disarticulated. The muscles were cleaned from the skulls. There was no apparent difference in the tympanic membranes of the treated and untreated animals at this time. The drums were thick, red and perforated. When the muscles were removed from the heads, the calvarium was also taken off. It was then an easy matter to separate the whole petrous portion of the temporal bone from the rest of the skull. The entire petrous portion was then fixed in formalin before being decalcified and sectioned.

The autopsy of the visceral organs of the treated animals failed to show any gross evidence of a generalized tuberculosis. The spleens of the untreated controls were enlarged. This was the only sign of a generalized tuberculosis. However, rabbits are not very susceptible to human tubercle bacilli, but they are very susceptible to bovine tubercle bacilli. Guinea pigs are more susceptible to human tubercle bacilli than rabbits. We have used less than a hundred guinea pigs to date. The ears of the pigs are very difficult to inject and are so small that there is too little mucous membrane in which to examine the histopathological changes. We, therefore, used rabbits to show the pathology of the treated animals and the controls.

The histopathology of the middle ear is the same in the treated animals as it is in the untreated controls, so that so far our experimental work does not show that sulfapyridine



Fig. 1. Chronic suppurative tuberculous inflammation of the middle and internal ear of a rabbit. No nerve involvement.

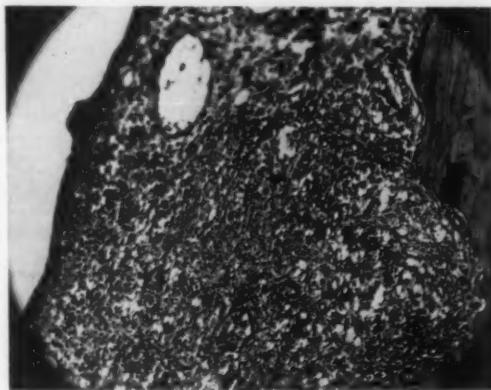


Fig. 2. Chronic suppurative tuberculous inflammation of the middle ear of a rabbit. No nerve extension.

has very much effect on the tuberculosis of the middle ear in rabbits. We purposely did not apply sulfapyridine directly to the middle ear in any of the animals because this would interfere with the taking of the microphotographs and would

make the interpretation of the pathology more difficult. Chemotherapy in actual practice has proved of value in streptococcal infections of the middle ear and mastoid when

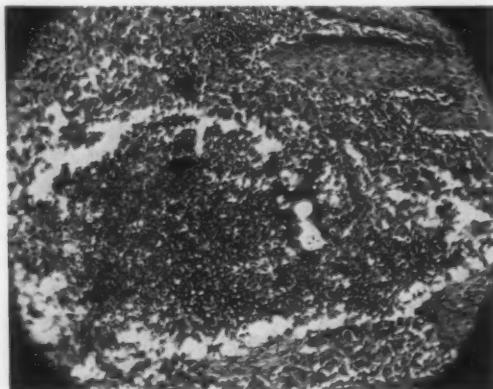


Fig. 3. Chronic suppurative tuberculous inflammation of the middle ear of a rabbit. No nerve extension.

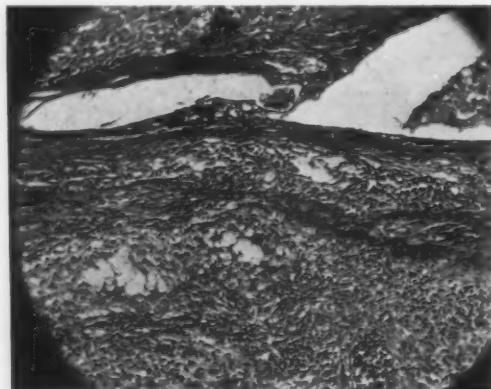


Fig. 4. Chronic suppurative tuberculous inflammation of the middle ear of a rabbit. No nerve extension.

the drug has been placed in the infected area of the temporal bone. Sulfapyridine when so used in patients has some value, but it has not proved of as much value as the sulfanilamides in streptococcal infections.

Figs. 1, 2, 3 and 4 show no difference in the histopathology. Figs. 1 and 2 are from the treated rabbits. Figs. 3 and 4 are from the untreated controls.

Summary and Conclusions: Our experimental work last year and this with guinea pigs shows that the treated animals lived longer and had less extensive lesions of tuberculosis than the untreated controls. However, the results are not as gratifying as we had hoped from some of the reports in the literature. Sulfapyridine has some value in the treatment of tuberculosis but it has not produced brilliant results. In rabbits it is almost without any value.

We want to express our appreciation to Dr. James Chessen, Senior Resident in Otolaryngology, for his valuable help with the examination of the gross specimens, and to Mr. Glenn E. Mills, photographer, for the microphotographs.

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THE INFLUENCE OF NASOPHARYNGEAL HYPERPLASIA ON THE EAR: HISTOLOGIC EXAMINATION OF HYPERPLASTIC LYMPH FOLLICLES AFTER IRRADIATION.*†

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This report is concerned with the histologic examination of tissue removed from the neighborhood of the Eustachian orifice in 22 children between the ages of 6 and 12 years. Each subject had previously been subjected to the removal of tonsil and adenoid tissue but presented hyperplasia of the residual portions of Waldeyer's ring, as well as the lymphoid tissue of the nasopharynx. In each instance there existed a hearing loss, demonstrated by audiometer tests, and of sufficient degree to warrant treatment. Tissue sections were obtained before and at intervals after irradiation of the nasopharynx. An attempt was made to correlate the findings with the clinical course.

Subjects with either personal or familial histories of allergy were excluded from this study for the following reasons: 1. The histological character of the apparent hyperplasia of allergy^{1,2} differs from that of true hyperplasia due to chronic infections;^{3,4} and 2. a somewhat different effect upon the acoustic mechanism follows lymphoid alterations in the nasopharynx due to allergy and those due to chronic infection.

METHODS.

Tissue from the hyperplastic areas was removed by means of a Grunwald biting forceps and immediately immersed in a 4 per cent dilution of formaldehyde U.S.P. for fixation. Double staining with hematoxylin and eosin was employed. At least three sections from each block of tissue were examined.

Prior to irradiation, no form of therapy was employed for at least six weeks. During and after irradiation, the admin-

*Read at the Seventy-fourth Annual Meeting of the American Otological Society, Inc., Atlantic City, May 26, 1941.

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Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, June 29 1941.

istration of iodides, endocrine and vitamin products, and the use of inflation and massage were specifically avoided.

Three methods of irradiation were employed.

*Technique A**: Roentgen rays generated at 200 kv., and filtered through 0.75 mm. of copper and 2.0 mm. of aluminum, were directed transorally through a circular cone measuring 3 cm. in diameter at a target skin distance of 25 cm. The rays were directed through the soft palate to either side of the midline and into the region of the fossa of Rosenmüller. Each intraoral portal was treated daily, 200 r. measured in air being directed into each nasopharyngeal area contiguous to the Eustachian orifice. The total dose delivered to each nasopharyngeal area was 600 r. measured in air. Treatment was carried out on three consecutive days and such a group of daily exposures was considered one series. Such a series was not repeated in less than three months and was rarely repeated more than once. This amount of treatment produces a faint erythematous blush over the soft palate and a subjective sensation of warmth in the throat about two to three weeks following the completion of the intraoral Roentgen therapy.

Technique B†: 0.5 gram-minutes of radium was applied to the posterior pharyngeal wall by means of a nasal applicator introduced through each nostril. In one week, intermediate Roentgen therapy (140 kv.) through $\frac{1}{2}$ mm. of copper and 1 mm. of aluminum was administered to the sinuses, a dose of 90 r. being given through the sinuses anteriorly. A week later, 0.5 gram-minutes of radium was given to each side of the posterior nasopharynx on a curved applicator, introduced through the mouth and held above and posterior to the soft palate. This was followed in a week by 90 r. of intermediate Roentgen therapy administered to the sinuses anteriorly. At weekly intervals, two more doses of 90 r. were administered through each antrum and directed toward the posterior pharyngeal wall. Thus, a total 2.0 gram-minutes of radium, filtered through 1 mm. of platinum, was applied to the posterior nasopharynx. The position of the applicator was checked by fluoroscope. (It was felt that more uniform dis-

*Technique devised by Dr. E. P. Pendergrass and Dr. P. J. Hodes.

†Technique devised by Dr. J. H. Vastine II.

tribution of irradiation could be obtained by making one application through the nares and one through the mouth.) A total of 180 r. units of Roentgen therapy was given through the sinuses anteriorly and 180 r. were given through each antrum, directed toward the posterior pharyngeal wall. The total amount of intermediate therapy filtered through $\frac{1}{2}$ mm. of copper and 1 mm. of aluminum was 640 r. units. This irradiation was given over a period of six weeks, and no subsequent irradiation was used.

Technique C: By means of an applicator which could be placed in position against the Eustachian orifice while observed through a nasopharyngoscope passed through the opposite nostril, 0.5 gram-minutes of radium was applied to alternate sides of the pharynx at weekly intervals. Each side received four such exposures. Six weeks later, a similar series of exposures was carried out. Each side received a total of 4.0 gram-minutes of radium.

Regardless of the technique employed, biopsy specimens were obtained two weeks, four weeks and six months after the final irradiation.

CHARACTERISTICS OF HYPERPLASTIC PHARYNGEAL LYMPHOID TISSUE REMOVED PRIOR TO IRRADIATION.

The examination of sections of tissue removed from the vicinity of the orifice of the Eustachian tube demonstrated great diversity in the structure of individual lymph follicles. Some nodules were found to consist almost exclusively of small lymphocytes, some contained pale centres (so-called germinal centres) surrounded by dark marginal zones consisting of lymphocytes and a few reticuloendothelial cells, while others showed all transitions from a preponderance of large cells, typical of the cells found in germinal centres, to an entire dissolution into lymphoid tissue. Occasionally, a follicle was found to consist merely of a fine reticular network in which were enmeshed a few lymphocytes and occasional plasma cells and proliferating endothelial cells.

Since successive biopsy specimens may present entirely different types of nodules, great caution must be exercised in interpreting the histological appearance of a single specimen. In general, however, the tissue removed prior to irradiation

differed little, if at all, from similar tissue previously studied to determine the histological changes incident to chronic infection.^{3,4} Briefly, the chief alterations are those of hyperplasia and chronic inflammation. Mitosis and rapid proliferation of the cells of the nodule appear to be followed by an increase in the number of polyblasts. (The latter may indicate a stimulation of, or attraction for, reticuloendothelial units.) Edema within the nodules varies but is never as conspicuous a feature as it is in those removed from allergic individuals. Dilatation of lymph channels appears to occur beyond the confines of the nodules, while the lymph channels within and around the nodules appear to be largely obstructed and frequently obliterated. Fibroblastic activity is one of the characteristics of chronic inflammatory change and with the eventual contraction of the newly formed fibrous tissue, the lymph channels appear to be constricted from without. The perifollicular lymph spaces seem to be especially prone to obliteration by fibroblastic activity. Proliferation of endothelial cells within the lymph channels is probably an equally important cause of obstruction. The dilated segments of lymph vessels usually contain numerous cells, the majority being lymphocytes, but occasional plasma or large mononuclear cells may be found. (Although there is an initial hyperplasia of the adjacent glandular structures, atrophy ensues if chronic inflammatory activity is prolonged.)

CHARACTERISTICS OF HYPERPLASTIC PHARYNGEAL LYMPHOID TISSUE REMOVED AFTER IRRADIATION.

For various reasons, seven of the 22 patients did not receive a complete course of irradiation. Tissue obtained from these seven subjects at two- and four-week intervals after the last irradiation showed certain alterations which may be regarded as minimal.

Minimal Changes: The epithelial cells appeared slightly swollen but there was no evidence of desquamation. Leucocytolysis could not be demonstrated and the adult lymphocytes retained their cell outline with no change in the nuclei. Because there was no increase in cell fragments it was concluded that neither karyolysis or karyolexis had occurred. The follicular structure appeared edematous but otherwise unchanged, although there may be a slight increase of mito-

tic activity in the cells composing the germinal centres. There was questionable blurring of the endothelial cells of both the blood vessels and the lymphatics.

Tissue obtained from 15 of the 22 patients at two- and four-week intervals after the completion of irradiation showed changes which were regarded as maximal. These alterations were as follows:

The epithelial cells were swollen, often vacuolated, and detachment of the ciliated cells was not uncommon. Minute hemorrhages had occurred about and within the nodules, as well as elsewhere, and attested to the effect of irradiation upon the endothelium of the capillaries. In two instances such hemorrhage was found within 48 hours after the final irradiation. Evidence of hemorrhage may depend upon the finding of hemosiderin.

Irradiation produced striking effects upon the endothelium of the lymph capillaries. Whereas, sections removed prior to irradiation had shown proliferation of endothelium to the extent of obstruction of the channels, those removed after irradiation showed destruction of some endothelial cells, while those remaining were contracted. This created a distinct impression that the lymph channels were increased in number, but the appearance may be due to conversion of a multi-cellular wall into an incomplete unicellular wall. Even where fibrosis was still marked, there were definite lymph channels, although in many instances the walls were not intact.

Little alteration in the structure of the adult lymphocytes could be detected. There may be a slight increase in cytoplasm but the striation in the nuclei, previously described by other observers, was absent. Young lymphocytic cells presented marked nuclear disturbances or had undergone dissolution so that only cell fragments remained. The earliest and most profound changes occurred in the large cells composing the germinal centres. Karyokinetic figures, usually found in these cells, were faded and indistinct, while many cells appeared to have undergone various degrees of liquefaction. The reticular network in some sections was fragmented, but even in tissue removed six months after irradiation there was no obvious increase in hyaline degeneration.

Tissue removed six months after the completion of irradiation was similarly examined. At this time the reappearance of lymphocytes indicated beginning regeneration but the so-called germinal centres probably do not reappear within this interval. Their absence may account in part for the gross impression that the follicles are diminished in size. There was also, however, a condensation of the reticular network and an absolute as well as a relative diminution of fibrous tissue.

It was rare to find dilated lymph channels after six months and the apparent increase in the number of channels was not accompanied by evidence of proliferation of endothelium. The apparent increase in the number of lymphatic channels was a striking and unexpected result of irradiation.

Tissue removed at this time (six months) was found to be relatively free of debris resulting from cell destruction. In many nodules the evidence of chronic inflammatory change was lacking.

No statistical significance can be attached to the clinical effects of irradiation upon the hearing level in this small group of patients receiving three different methods of treatment. The attempt to correlate the findings with the clinical course failed because of variable factors beyond our control.

An arbitrary standard was set whereby an average gain of 20 decibels throughout the tone range 128 to 16,384 was to be regarded as improvement, even though this occurred in but one ear. It may be of interest to present the result of applying this standard to the 15 patients receiving a full course of irradiation (see Charts 1 and 2). Of four patients completing Technique A, three were improved; of four patients completing Technique B, two were improved; of seven patients completing Technique C, two were improved, while three patients not completing Technique C were improved.

DISCUSSION.

Nasopharyngeal lymphoid hyperplasia has long been regarded as an etiological factor in infections of the middle ear and contiguous structures. That such infections may frequently be followed by varying degrees of transient or per-

manent acoustic loss is generally conceded. The ensuing disability is usually regarded as conduction type deafness. A revision of these views seems indicated since the reports of Crowe and his co-workers,^{5, 6, 7, 8} describing an insidious and progressive type of deafness resulting from abnormal growth of lymphoid tissue about the fossa of Rosenmüller, the orifice of the Eustachian tube and in the mucosa of the tube itself. Crowe⁸ states that "a long-continued partial obstruction of the Eustachian tubes in children causes retraction of the tympanic membrane, impaired hearing for high tones, with relatively good hearing for low tones, and sometimes a total loss of hearing by bone conduction."

The mechanism whereby abnormal lymphoid tissue produces profound changes in the middle and perhaps also in the internal ear remains obscure. The factor of mere obstruction in the Eustachian tube has received much attention and considerable significance has been attached to the observations of Wolff,⁹ who found that while the Eustachian tubes of the monkey, cat, rabbit, white rat and guinea pig showed great variation in structure, they possessed one feature in common which was in contrast to human material; *i.e.*, the lumen appeared widely patent throughout. Polvogt and Babb¹⁰ have demonstrated the presence of lymphoid tissue in all parts of the Eustachian tube of individuals with good hearing. Concomitant alterations in the Eustachian lymphoid structures are almost certain to accompany hyperplastic lymphoid changes in the nasopharynx and this plays a rôle in obstruction of the Eustachian tube.

Aside from the obstructive features and the ability to harbor infection (toxic factor), little attention has been paid to the rôle of the lymphoid tissue and lymph channels of the Eustachian tube, although many lymphatics of the middle ear pass along the wall of the Eustachian tube and end in the retropharyngeal lymph nodes. A better understanding of the action of the lymph channels of this region is most desirable. Although the classic observations of Clark and his co-workers¹¹ have provided much basic information concerning the behavior of lymphatic vessels in living mammalian tissue, direct observations with high power magnification upon the lymphatics of the Eustachian tube in living mammals has not been accomplished.

Many obvious difficulties prevent adequate examination of tissue from the Eustachian tube of living human beings. Some conception of what occurs in the lymphoid tissue and lymph channels of the Eustachian tube, however, can be obtained by examining similar tissue removed from the fossa of Rosenmüller or the region about the orifice of the tube. We are reasonably certain that changes in such tissue closely resembles those occurring in lymphoid structures within the canal.

Satisfactory studies of the effects of irradiation upon the lymphoid structures of the Eustachian tube of living individuals are likewise beset with difficulties which have not been overcome. In this area an evaluation of the effects of irradiation must be largely based upon observations made on similar, contiguous and accessible tissue, such as that about the Eustachian orifice.

The lymph nodules and the lymph channels are not independent and isolated structures but an intimate and necessary part of the body mechanism. Pullinger and Florey¹² have demonstrated that reactions occurring in injured tissues include the lymphatics on the same footing as the blood vessels. It is well to emphasize therefore that, although our main interest may be in the effects of irradiation upon the lymphatic structures, there is also a concomitant and perhaps equally important effect upon the adjacent tissues. Pendergrass and Hodes¹³ have pointed out the advantage of irradiating infections through portals large enough to extend beyond the border of infection, stating that this induces an increased blood flow not only in the periphery of the lesion but, what may be more important, in the larger area of normal tissue about the infection. Thus, an original area of passive hyperemia is transformed into an area of active hyperemia. Increased blood supply not only increases the temperature and local concentrations of electrolytes but also decreases edema by increasing lymphatic flow.

Concerning the effects of irradiation upon lymphatic tissue, there continue to be differences of opinion. The lymphocyte has been regarded as vulnerable to Roentgen rays since 1903, when Heineke¹⁴ found destruction of a greater part of the lymphocytes in and around the follicles after irradiation of the lymph nodes of pigs, rabbits and dogs. These

findings were subsequently confirmed by Welsh,¹⁵ Warthin,¹⁶ Warren and Whipple,¹⁷ Taylor, Witherbee and Murphy¹⁸ and others.¹⁹ All of these investigators used large portals and excessive quantities of irradiation to produce the effects reported.

A dissenting note was sounded by Quick and Cutler²⁰ in 1925. They reported the examination of lymph nodes removed subsequent to heavy irradiation in 40 cases of oral carcinoma. They found the immediate effect of irradiation to be an increase in the mitotic figures of the germinal follicles, and evidence of enlargement with hyperplasia. In their opinion the lymphoid tissue was resistant and lymphocytes retained their cell outline. The lymphoid follicles stood out prominently and appeared enlarged and edematous. They also stated that Ewing had repeatedly observed that normal lymphoid tissue resisted large doses of irradiation.

That irradiation may have only a temporary effect upon lymphoid tissue was indicated by Holthusen,²¹ who observed that lymph follicles exhibited a greater radiosensitivity but at the same time also evinced a greater capacity for regeneration. From a few resistant cells the obliterated spaces of reticulum of an irradiated lymph node could again become filled in a relatively short time. Crowe⁷ noted the necessity for repeated irradiation in the control of some instances of pharyngeal lymphoid hyperplasia. Taussig,²² in a histologic review of 1,039 glands removed in cancer of the cervix, uterus or vulva, described the condition of lymph nodes removed three to four weeks after deep Roentgen therapy and observed that nodes removed three to six months after irradiation showed regeneration of lymph follicles.

COMMENT.

Irradiation by three different and acceptable techniques failed to produce histologic changes that varied according to the technique employed. Tissue removed at the same interval after the completion of irradiation presented the same histologic alterations, regardless of which technique was used. The immediate effect of irradiation upon the hyperplastic lymphoid tissue of the nasopharynx appears to be minimal as far as the lymphocyte is concerned, but the endothelium of both the lymphatics and the blood vessels is profoundly

altered. The cells of the germinal follicles are especially radiosensitive. While reduction in the bulk of the follicles followed irradiation, there was no widespread destruction of adult lymphocytes but rather destruction of the other cellular constituents of the nodules. This histologic appearance after irradiation suggests that increased function of the lymphatic vessels in and about hyperplastic lymphoid tissue exhibiting chronic inflammatory changes may be a direct result of this form of therapy.

Whether or not disturbances of lymphatic flow are factors in inducing changes in the middle ear which lead to impaired hearing is mere speculation. Since irradiation of hyperplastic pharyngeal lymphoid tissue is sometimes followed by improvement in hearing, and since such therapy may also produce increased function of lymphatic vessels, further consideration of the effects of lymphatic obstruction upon the middle ear seems indicated.

CONCLUSIONS.

1. Comparable forms of irradiation produce similar histologic changes in hyperplastic pharyngeal lymphoid tissue.
2. An important result of irradiation is the freeing of previously obstructed lymph channels.
3. Evidence of regeneration of lymphoid follicles was obtained six months after the final irradiation.

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1912 Spruce Street.

SURGERY OF THE AURICLE, INCLUDING TOTAL RECONSTRUCTION AND PROTUBERANT EARS.*

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Plastic surgery of the ear was practiced in ancient times in India. At the end of the sixteenth century, Tagliocozzi, in his well known work, "De Curtorum Chirurgia per Insitionem," devised a good method of repairing subtotal losses of the auricle by using skin from the scalp and neck adjoining the deformed ear.

In the nineteenth century, total reconstruction of the auricle was attempted by several surgeons, including Dieffenbach and Szymanowsky, without entirely satisfactory results.

In 1908, Schmieden constructed an auricle from a skin flap from the region of the breast, in which he had implanted a piece of rib cartilage. In 1916, J. Joseph devised a method of forming an entire auricle by transplanting skin from the upper arm. In 1930, the same author, Joseph, developed still another method of making an auricle by the use of skin from the neck, in which he had implanted a piece of ivory carved in such a way that it formed a skeleton-like framework for the ear. The ivory was inserted in the skin of the neck below the defective auricle and later moved to the normal position by sliding a pedicle flap upward.

The disadvantage of this method is that pressure, such as that caused by lying on the new-formed ear, is apt to produce necrosis of the skin over the ivory, or infection may take place, necessitating the removal of the foreign body.

In 1928, Pierce, of San Francisco, reported a method for total reconstruction of the ear by the employment of skin from the retroauricular region, rib cartilage, and the use of a tubed flap from the skin of the neck to form a helix. Pierce's operation is by far the best yet devised.

Ear defects and deformities may be *congenital* or *acquired*. In *congenital defects* the auricle may be wholly missing, the

*Read before the New York Academy of Medicine, Section on Otolaryngology, Oct. 18, 1939.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, Dec. 19, 1939.

ear rudimentally developed, or only the lobule may be present, together with parts containing rudiments of hyaline cartilage adjoining the external auditory canal.

Acquired defects may be due to *a.* disease; or *b.* trauma. Under the heading of *disease* we have carcinoma, sarcoma, deformities from infections of the cartilage from furunculosis or after radical mastoid operation.

b. Traumatic defects and deformities, including partial or total loss of the auricle, may be caused by gunshot wounds,

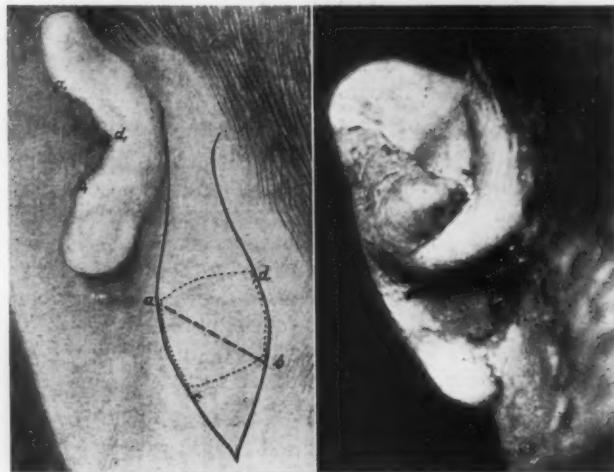


Fig. 1. Method of closing subtotal loss of auricle with skin flap (Joseph).

animal bites, frostbites, freezing, automobile or other mechanical injuries.

Treatment is essentially the same for both the congenital and acquired deformities. *Partial losses* of the substance of the auricle may be repaired by means of a folded skin flap taken from the postauricular region or neck, avoiding the hairline. After two weeks, when the circulation is thoroughly established, the pedicle is divided. In cases presenting loss of the helix alone, a thin tube flap from the neck gives gratifying results.

In young children, where the ear is small and curved on itself, it is best to attempt to "uncurve" the auricle and suture it to the scalp in a position which will allow the ear to grow without the production of greater deformity (Davis).



Fig. 2. Protruding ears in a boy.

At present I have a boy of 10 to 12 years with such a deformity, the result of infection of the auricle following a radical mastoid operation several years ago. He is awaiting his turn to be admitted to Bellevue Hospital in the next two or three weeks. I plan to cover the wrinkled anterior surface of the pinna with skin taken from the neck by a pedicle,

after embedding a piece of cartilage from the ear of the child's mother. The ear itself I shall fasten to the scalp in the desired position until it adapts itself to the proper form and shape.

Protruding ears are encountered not infrequently. In children, the best time to operate is at the sixth year, before the child goes to school and is subjected to ridicule by his fellow pupils. My youngest case was a child of 3 years, and the oldest an adult in his forties. "Flop ears" are more common in males than in females. The simplest and best operation to cure this deformity is the excision of an elliptical area of skin and cartilage. If an operation is indicated, it is always necessary to remove cartilage as well as skin.

Operation: An elliptical skin incision is made over the posterior aspect of the auricle and postauricular region. This skin is then excised and discarded. Next, a fairly large piece of auricular cartilage is carefully dissected away and cut off. Sufficient cartilage must be removed to permit the auricle to fall back into the desired position and stay there without tension. After careful ligation of all bleeding points, the skin wound is sutured with silk, the contours of the auricle filled with pledges of cotton saturated with alcohol, and a pressure bandage applied for two weeks. (A moving picture of this operation was shown.)

A word about satisfying the patient. My patients have repeatedly told me after operation that what they want is that the ears should be fixed at the proper angle and not "stick out" from the head. They do not object if the folds and contour of the pinna are not exactly the same as before.

"*Drooping ear*" is a rare condition, which curiously enough I have encountered twice in the past six months. It is often associated with a protruding auricle.

In the drooping ear the "superior bow of the helix is rolled downward away from the head, more or less covering the scaphoid fossa." (Rigg and Waldapfel, *Jour. A. M. A.*, July 8, 1939.) Instead of excising a large piece of the auricular cartilage, these authors retain a tongue-like portion and fix it with sutures under the periosteum of the temporal bone so as to overcome the drooping deformity by holding up the top of the auricle.

Total reconstruction of the auricle is a difficult surgical procedure requiring considerable time as well as patience on the part of both the surgeon and the patient. The best operation is that described by Pierce, whose technique I have followed in the main in the following case:

A young man walking along a country road at night was struck by an automobile and suffered a complete loss of the auricle, with the exception of the tragus and part of the

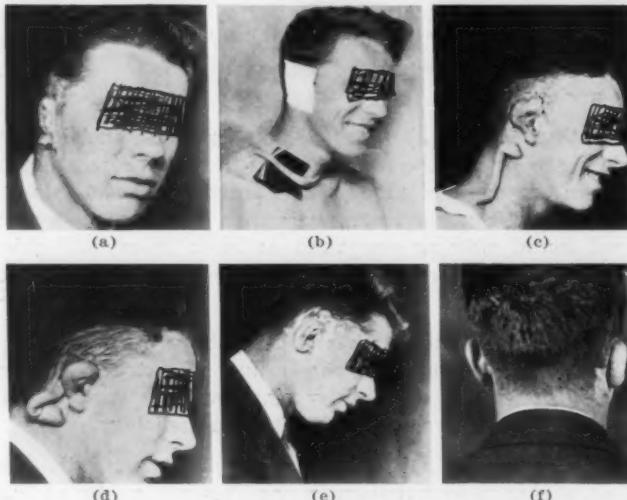


Fig. 3. (a) Loss of entire auricle except part of lobule and tragus. (b) Shows tubed pedicle in neck. (c) One end of pedicle has been transplanted to neck below auricle and an epithelial inlay and stent has been sewed in place under the scalp. (d) Shows the newly formed auricle after the removal of the wax model. The posterior surface of the auricle and the adjoining raw area on the scalp are now covered with epithelium, except below, where the epithelial graft failed to "take." Here, the upper end of the tube flap was used to cover the raw surfaces on the auricle and scalp. (e) and (f) Show the completed operation. The tube flap has been utilized to form a helix. Still another operation is indicated to narrow the helix by taking out a wedge-shaped piece of tissue posteriorly.

lobule. A series of operations was performed, the first on May 16, 1937, and the last on April 20, 1938. General anesthesia was employed for the first operation, and all others were carried out under novocain infiltration.

First operation, May 16, 1937: Four pieces of rib cartilage were removed from the right costochondral junction at the

level of the seventh, eighth and ninth ribs. Three of these were implanted above and behind the external auditory canal between the skin of the scalp and the temporomandibular fascia. The fourth piece of cartilage was buried under the skin of the chest for future use, if needed. At the same operation a tube pedicle flap was made in the neck just above the clavicle, as shown in the illustration.

Second operation: Several weeks later, this pedicle flap was lengthened posteriorly until it was 16 cm. in length.

Third operation, postponed by my summer vacation, took place Sept. 13, 1937. The anterior end of the pedicle was severed and implanted in the neck just below the site of the new auricle.

Fourth operation, Nov. 8 1937: A semilunar incision was made in the skin of the scalp through the temporomandibular fascia in the size and shape of the auricle desired. Thiersch grafts, taken from the thigh, were then placed about a stent of red dental molding compound, so as to cover both sides. The stent with its epithelial covering was then buried and the skin sutured.

Ten days later the stitches and stent were removed and the new auricle appeared as shown in the illustration. Thus, the posterior aspect of the new pinna and the raw area on the skull were both covered with the epithelial graft.

After several weeks I found that the lower part of the new auricle, due to poor nutrition in the Thiersch grafts at that point, became adherent to the scalp. I, therefore, separated the adherent portion of the pedicle flap, which I split for that purpose. Incidentally, I noticed that this procedure overcame a tendency on the part of the auricle to droop or sag.

Following this operation, at other sessions I readjusted the ends of the tube pedicle flap so that it could finally be employed to form a helix for the new auricle.

The *final operation* was performed April 26, 1938. At this time the following steps were carried out:

a. One end of the tube flap was severed.

b. A narrow strip of skin on the posterior circumference of the newly constructed auricle was excised.

c. The tube flap was split and attached to the skin edges prepared for it on the circumference of the auricle.

If properly carried out, this operation has two distinct advantages: 1. It produces an auricle which, later on, does not shrink in size. 2. The ear stands out from the scalp at the proper acute angle. The one disadvantage is that the new auricle sometimes has a tendency to sag or droop.

To overcome this drooping, I suggest the following method, which I have tried and found satisfactory:

Make the tube flap in the neck one-half to one inch longer than required to form the helix. If the new auricle droops, split the end of the tube flap and suture one portion to the posterior surface of the pinna and the other portion to the adjoining scalp after proper denudation. When circulation is established, the remainder of the tube pedicle is severed and used to form a helix as described above.

149 East 62nd Street.

EXPERIMENTAL OBSERVATIONS ON THE QUESTION OF AUDITORY FATIGUE.*†

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Introduction: The sensation of hearing is a complicated phenomenon dependent upon processes in both the peripheral sense organ and in the central nervous system. It seems that our knowledge on hearing can be improved if we are able to obtain more information on the mechanical processes in the cochlea, which produce the acoustic nerve stimulus. Additional information is desirable which permits us to distinguish more clearly between acoustic phenomena dependent upon cochlear conditions and those which originate in the higher centres of the nervous system. The acoustic reflex of the muscle of the middle ear offers a quantitative method of studying the acoustic stimulation in the cochlea independent from the cortex.

The acoustic stimulus originating in the cochlea reaches the primary acoustic nuclei through the VIIth nerve. Proceeding to the trigeminal nerve, it causes a contraction of the tensor tympani muscle. Similar stimuli reach the facial nucleus and go to the stapedius muscle. Cutting experiments have shown that the reflex acts without the higher centres.

When testing the tensor reflex we deal, therefore, with the lower part of the auditory apparatus alone.

If we test the hearing sensation, we deal with the whole auditory apparatus extending from the peripheral sense organ to the cortex. By comparing the acoustic reflex responses with the subjective hearing sensation it has been tried to separate the function of the higher centres from that of the lower part of the auditory sense organ.

In this paper the attempt is being made to analyze by this method a complicated acoustic phenomenon; namely, auditory fatigue.

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†This work was aided in part by a grant from the Douglas Smith Foundation of the University of Chicago.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, Feb. 12, 1940.

EXPERIMENTAL PROCEDURE.

Observations were made on animals and on the human. In the animal experiment, rabbits were anesthetized either by intravenous injection of ethyl carbonate (urethane), producing shallow general anesthesia, or by local application of 0.5 per cent novocaine. The method of exposing the muscles of the middle ear has been described in a previous paper.¹ The routine position of the animal was the recumbent position and the loudspeaker was placed five inches from the left ear of the animal, the pinna making a 45° angle with the body. The observer used a head mirror for lighting the cavity of the bulla, and a lens for magnifying the field. The

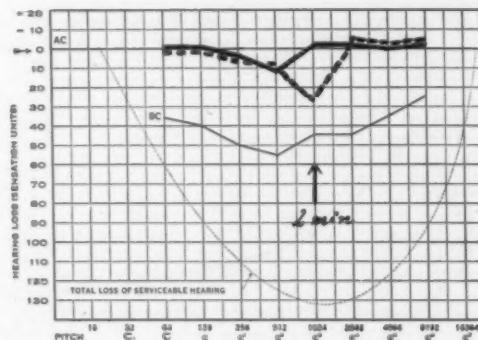


Fig. 1. Fatigue of hearing sensation. The solid line indicates the threshold of hearing sensation of a normal young male person (right ear). After the threshold was taken, the ear was exposed to a fatiguing tone (95 db. intensity, frequency 1,024, duration two minutes). The broken line indicates the threshold of hearing sensation immediately after the end of the fatiguing tone. Note: Selective, subjective auditory fatigue.

production of sound was carried out by an assistant. For the sake of objectivity the observer was not informed about his readings until the results were complete. As often as possible, the readings were checked by a second observer.

The experiments in the human were carried out both as tests of hearing sensation and reflex studies. For the subjective tests on hearing threshold, young, healthy men were taken, who were trained in auditory tests. A 2A Western Electric audiometer was used as sound source. Reflex tests were made on patients having a suitable perforation of the eardrum permitting observation of the stapedius tendon.

FATIGUE OF THE HEARING SENSATION.

Fig. 1 shows the hearing sensation of a normal human. The solid line is the normal hearing curve. A fatiguing tone with the frequency 1,024 and 95 db. intensity was applied for two minutes to the ear.

The broken line shows the effect. There is a dip in the curve specific as to the frequency of the fatiguing tone. In testing different persons it was found that the degree of fatigue varied greatly even when the identical stimuli were used. In the same person the intensity of fatigue is proportional to the intensity and the duration of the stimulus.

RECOVERY OF SUBJECTIVE FATIGUE.

By taking several hearing tests at definite intervals the recovery can be studied. In Fig. 2 the change of the hearing

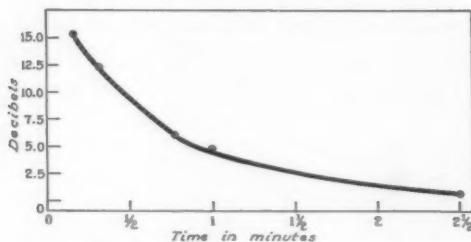


Fig. 2. Recovery of subjective fatigue. The ordinate is the decibel hearing loss due to fatigue. The abscissa is the time. The curvature of the curve signifies that recovery is slowing up. In this case two-thirds of the total hearing loss of 15 db. were recovered in the first minute.

threshold, immediately at the end of the fatiguing tone, was 15 db. Taking another reading 20 seconds later show 2.5 db. recovered. At the end of one minute, the threshold was only 5 db. above normal; in other words, 10 db. had been restored. Complete recovery was seen at the end of two and one-half minutes. Fig. 2 shows the recovery as a function of time.

SUMMATION OF SUBJECTIVE FATIGUE.

Another series of experiments dealt with summation of fatigue. A second fatiguing tone of equal frequency, inten-

sity and duration was used. Immediately after the effect of the first fatiguing tone was measured (see broken line curve, Fig. 3) the second tone was applied. The result is shown in

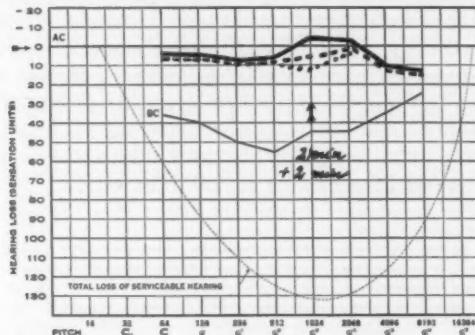


Fig. 3. Summation of auditory fatigue. In this experiment, the normal threshold of hearing sensation was taken first (indicated by solid line). Then a fatiguing tone (1,024 d.v., 85 db., two minutes' duration) was applied. As a result, the threshold was changed to the threshold indicated by broken line. Immediately after the threshold reading, a second fatiguing tone was applied (equal physical qualities). The result was a second elevation of the threshold as indicated by dotted line.

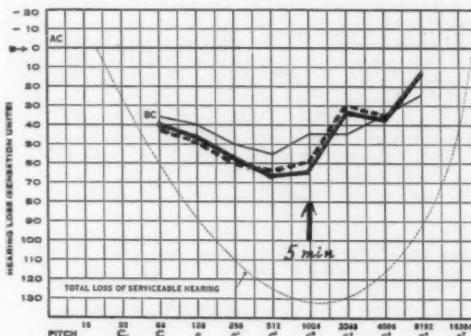


Fig. 4. Tensor threshold of a rabbit before (solid line) and after (broken line) the application of a fatiguing tone. Qualities of fatiguing tone: frequency 1,024 d.v.; maximum intensity, five minutes' duration. There is no definite change of threshold.

the dotted line. There is a further elevation of threshold. In contradistinction of other types of fatigue which will be demonstrated later, the phenomenon of summation of fatigue is observed here.

OBJECTIVE TESTS ON AUDITORY FATIGUE.

In addition to these subjective examinations, objective tests were carried out both in animals and in the human.

Fig. 4 shows the threshold of the tensor reflex of a rabbit. The solid line indicates the normal threshold. The broken line is the threshold determined immediately at the end of a fatiguing tone of maximum intensity and of five minutes' duration.* The curves show no greater changes in the readings than could be normally expected in two different readings. No definite change of threshold due to the exposure to the fatiguing tone can be seen in the curve.

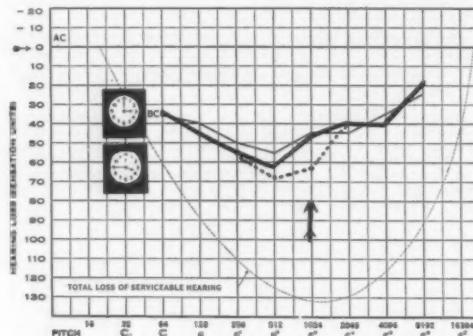


Fig. 5. Effect of a fatiguing tone on the threshold of the tensor reflex in the rabbit. Normal threshold (3:00 o'clock) represented by solid line. The qualities of the fatiguing tone were: frequency 1,024, duration 45 minutes, intensity maximum; i.e., approximately threshold of feeling. The curve taken immediately after the fatiguing tone (3:45 o'clock) is identical in the low and high tones; however, raised in the proximity of the fatiguing tone (broken line).

In the human, objective tests can be carried out in patients in whom the tendon of the stapedius muscle is visible through a perforation of the eardrum (Lindsay, Kobrak and Perlman²).

An identical tone as used in the former fatiguing experiments was used, with the effect that definite subjective fatigue was produced. The reflex curve, however, did not change.

The next group of experiments shows the effect of stronger fatiguing tones.

*The sound producer as used in these experiments generated maximum stimuli which were very close to the threshold of feeling.

Fig. 5 shows the normal tensor threshold of a rabbit (solid line) before a continued tone of 45 minutes' duration was applied. The frequency of the fatiguing tone was 1,024; the intensity in the proximity of the threshold of feeling. The broken line shows the threshold taken immediately at the end of the fatiguing tone. The frequency of the fatiguing tone shows the greatest change; namely, 17 decibels. The immediate neighbor frequency 512 dropped 7 decibels. The thresholds of the lower and higher frequencies did not change materially.

A stronger and broader effect of the fatiguing tone was observed in another experiment, which is demonstrated

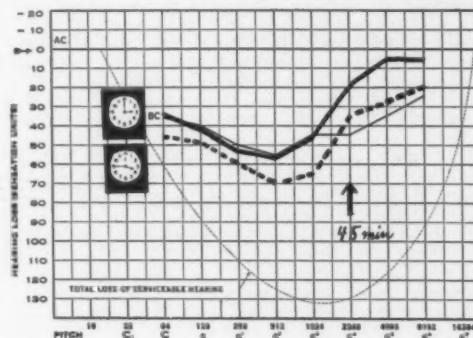


Fig. 6. The same experimental procedure as in the previous figure. The solid line represents the normal tensor threshold of the rabbit. Fatiguing tone (frequency 2,048 at maximum intensity), begun at 3:00 o'clock, ended at 4:00 o'clock. There was a uniform raise of threshold as indicated by broken line.

in Fig. 6. Here, all frequencies have been affected rather equally.

The next group of experiments deals with the recovery of the reflex fatigue.

Fig. 7 shows the normal tensor reflex as a solid line. Due to a fatiguing tone of 45 minutes' duration, the curve went down to the dotted line. This reading was taken at 3:00 o'clock, directly at the end of the fatiguing tone. Then we waited five minutes and took a reading at five minutes after 3:00. Recovery had set in and the threshold was found as

indicated by the dotted line. Again, five minutes later — 3:10 — the threshold had gone up again. Complete recovery was accomplished after about 25 minutes.

Fig. 8 shows the recovery as a function of time for the frequency 1,024. The abscissa is the time in minutes after

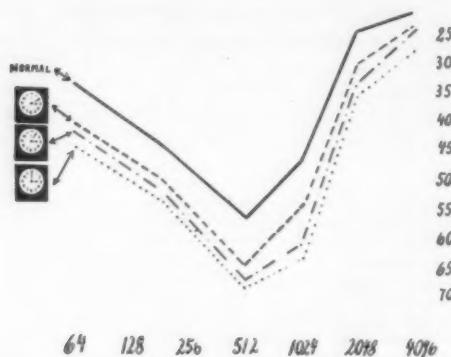


Fig. 7. Recovery of objective fatigue. The solid line indicates the normal threshold of the acoustic tensor tympani reflex. A fatiguing tone (frequency 1,024, duration 45 minutes, intensity maximal; i.e., close to the threshold of feeling), changed the threshold as indicated by the dotted line. Subsequent tests carried out in five-minute intervals. Complete recovery observed after 25 minutes.

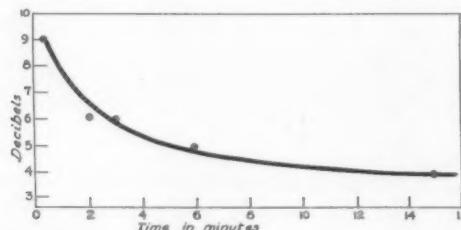


Fig. 8. Recovery of objective fatigue. The abscissa is the time in minutes, the ordinate represents the hearing loss due to fatigue. Note the resemblance between the recovery of subjective auditory fatigue (see Fig. 2) and of objective fatigue.

the end of the fatiguing tone. The ordinate designates the hearing loss; i.e., the number of decibels which the reflex threshold changed by fatigue. In this experiment there was a loss of 9 decb. at the first reading directly after the end of the fatiguing tone. Two minutes later, the loss was only

6 decb. A little later it was 5 decb., etc. The shape of the curve demonstrates that the recovery is speedier in the beginning. Later the curve flattens out.

The reason for demonstrating here the recovery curves is that there is a third type of observations which do not show the qualities of recovery as demonstrated in these curves.

This effect is observable not as much in the threshold determination at the end of the fatiguing tone but is observed during the fatiguing tone.

If a loud tone is given for a considerable time, the tetanic contraction of the tensor muscle diminishes slowly. At the end of the tone a slight relaxation can be seen.

If we repeat the same tone immediately after the end of the primary tone we find a contraction as strong as in the beginning. There is no rise in threshold, there is no recovery period. For this reason we consider this phenomenon as different from the fatigue. If one starts a third tone of similar qualities immediately at the end of the second, the result is the same: slow relaxation of the tetanus during the tone, but strong contraction to the new tone. The phenomenon of summation as observed in the former fatigue experiments is lacking.

The next group of our experiments deals with interrupted tones. If intermittent acoustic stimuli are used, no definite signs of fatigue can be observed. It is not necessary to interrupt the tone completely; a change of intensity (provided it is marked enough) or frequency has the same effect as discontinuing the tone completely. We have observed animals in acute experiments for many hours. An interrupted tone was given for nearly two hours. Since the observers of the reflex showed symptoms of strain, the reflex movements were recorded by a movie camera. Similar observations and movies were taken on the stapedius reflex of the human. Practically all acoustic stimuli of our daily life offer enough interruptions, or at least changes of frequency or intensity, so that a pronounced reflex fatigue does not set in.

The last group of our experiments deals with fatigue symptoms due to two tones.

If one gives a continued tone of, *e.g.*, five minutes' duration, the contraction of the tensor muscle is slowly relaxing.

If one adds, during the sounding of the first tone, a second interrupted tone of different frequency, the tensor reacts to the secondary tone with typical contractions.

Contrary to our expectations, the result was the same when the secondary tone had the same frequency as the primary tone. The explanation for this finding will be discussed later.

DISCUSSION.

The lack of a clear conception on auditory fatigue is demonstrated by the fact that some authors have denied the existence of fatigue, and some have chosen to replace it by another term; *e.g.*, experimental deafness (Rawdon Smith^a).

In this paper, auditory fatigue is considered a reversible condition of the auditory sense organ, in which the effect of acoustic stimulation becomes diminished after prolonged stimulations.

It is apparent that the words "effect of stimulation" can be applied both to subjective hearing sensation and objective changes of the reflex response. The adjective "reversible" separates the condition clearly from permanent damages.

The following questions were studied:

1. Is auditory fatigue an entity in regard to location of the origin of symptoms?
2. What is the rôle of auditory fatigue in the normal person under normal acoustic conditions?

According to this program, three groups of experiments were planned. The first group dealt with observations on subjective fatigue; the second group on objective fatigue; the third group revealed results which cannot be classified either as objective or as subjective fatigue but have been termed "acoustic adaptation."

In the first group of experiments, a diminished subjective auditory response was found which had no parallel objective finding in the reflex examination. The assumption was made, therefore, that a cochlea emitting an undiminished reflex stimulus cannot be responsible for the decrease of hearing sensation. It seems, therefore, that the site of this fatiguing phenomenon must be located above the reflex level. The term

"central fatigue" seemed appropriate. Rawdon Smith, who studied fatigue with a method different from ours, has arrived at similar conclusions. He finds one type of fatigue which he calls central fatigue. It is interesting that clinical observations exist which seem to give further evidence of "central fatigue." Neurasthenic persons when tested by a tuning fork hear the tone in the beginning but notice a premature decrease and disappearance of the tone. If one removes the tuning fork and then offers the tone again after a few seconds, the tone is reheard. This procedure can be repeated several times. The phenomenon is explained as pathological fatigue and recovery of the auditory sense organ. Albrecht, who published these observations, remarks that these persons have a generalized tendency of premature and extensive fatigability.

The second group of experiments demonstrates the effect of fatiguing stimuli, both objectively and subjectively. While it is impossible to determine the amount of central fatigue in this group, it can be assumed that there is definite fatigue in the lower part of the sense organ of hearing. The possible site of objective fatigue is the cochlea, the acoustic nerve, the primary acoustic nuclei, the connection with the motoric trigeminal nucleus, this nucleus, the trigeminal nerve and, finally, the tensor tympani muscle. As a general biological rule, one can state that the nerve fibre is less apt to become fatigued than the ganglion cells or nerve endings; therefore, the acoustic nerve is less likely to be the seat of the fatigue than the cochlea or the primary acoustic nuclei. In his article on audition in Nagel's Handbook, Schaefer has for this reason denied the term fatiguing of the ear nerve. The centrifugal part of the reflex arc can be eliminated for two reasons: 1. There are a few nonacoustic stimuli which produce regular tensor contractions during the fatigue period (*e.g.*, electrical stimulation of the neck muscles). 2. The fatigue threshold curve as given in Fig. 5 shows a rather specific raise of threshold around the frequency of the fatiguing tone. It is not conceivable that in the case of muscle fatigue the tensor would respond normally to some frequencies but show diminished response to the frequency of the fatiguing tone. Both the cochlea and the primary acoustic nuclei are, therefore, the most likely sites of the reflex

fatigue. In order to differentiate between cochlea and primary acoustic nucleus, the following deduction may help:

The transitory changes of the hearing threshold due to auditory fatigue, and the permanent structural damages due to excessive acoustic stimulation are not clearly separated. It seems possible that there is a gradual transition from reversible fatigue symptoms to permanent tissue damages. The histological pictures show the first definite damage in Corti's organ. For this reason it seems reasonable to assume that the site of the functional changes underlying the "reflex fatigue" are located in the cochlea.

In this study, objective tests of auditory function were made, using the tensor reflex as indicator when testing the effect of acoustic stimulation. Using the technique of Wever and Bray, Hughson and Witting⁴ have studied auditory fatigue objectively in the animal. For reason stated elsewhere, this laboratory is interested to a great extent in comparing the results obtained by different experimental methods.

It is our opinion that the electrical methods have been used in animal experimentation before a clear demonstration of their reliability as hearing indicator has been given. While in many instances the electrical cochlear responses go parallel with the act of hearing, it is apparent that in certain experimental conditions (for example, acute limited lesions of the cochlea), the electrical potentials cannot be considered indicators of hearing sensation.

Objective experimentation on auditory fatigue is another example in which discrepancies between the acoustic muscle reflex and the electrical potentials are found. The experimental conditions used by Hughson and Witting were repeated as closely as possible in our experiments: The frequency of the fatiguing tone and time of application were identical. The intensity was maximal; *i.e.*, approximate to the threshold of feeling. Hughson and Witting found that the potentials of the acoustic nerve do not return to their initial value within the time of an acute experiment. "The effect persists for approximately 24 hours, when recovery begins to manifest itself. After 72 hours, little, if any, effect can be noticed." In contradistinction to this slow recovery the muscle reflex shows recovery in less than one hour.

The last group of experiments dealt with the observations during the acoustic stimuli. Apart from a few observations of Kato,⁵ the fatigue of the tensor reflex has not been studied systematically in the animal. In the human, the findings of Lüscher⁶ are available. In our animal experiments, the tensor was found to diminish its contraction gradually during prolonged acoustic stimulation. This phenomenon is different from true fatigue, insofar that it does not show a recovery period. The symptom of summation is, therefore, lacking, too.

Von Kries and, later, Lüscher have drawn the attention to the fact that the stimulus changes the irritability of a sense organ. Von Kries had called this phenomenon "Umstimmung."

In the eye, we know of two mechanisms which change the irritation of the sense organ. A peripheral muscle reflex, the light reflex of the pupil, and the light-dark adaptation. It seems that we have similar conditions in the ear; a muscle reflex in the periphery acting fast, protecting against sudden stimuli, and, in addition, the slower phenomenon of *acoustic adaptation* which changes the sensitivity of the sense organ.

We consider the observations made in this group as experimental evidence for the existence of acoustic adaptation.

SUMMARY.

Acoustic reflexes and hearing sensations are observed under the influence of a fatiguing tone. According to the findings, the phenomenon of auditory fatigue is divided into three different types. There are observations which show subjective fatigue without signs of diminished cochlear irritation. This fatigue is interpreted as *central fatigue*. The second group consists of experiments which show an elevation of the auditory threshold, both objectively and subjectively. This kind of fatigue is located either in the cochlea or in the primary acoustic nuclei. It is more likely that the seat of this fatigue is the cochlea. The third group of experiments consists in observations of the reflex contractions during the prolonged stimulation. Observed is a slow relaxation of the muscle contraction. This relaxation is different from true fatigue, since recovery symptoms observed in true fatigue are missing. This phenomenon may be interpreted as *acoustic adaptation*.

The observations made in these experiments are, therefore, grouped as central fatigue, peripheral fatigue and auditory adaptation. The acoustic stimuli of daily life do not fatigue the acoustic reflex of the muscles of the middle ear.

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SUPPURATIVE ALVEOLITIS AND ITS EFFECT ON THE MAXILLARY SINUS.*

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The teeth and infections from the alveolar process may be included among the known causes associated with maxillary sinusitis. In some individuals, at the ages past the third decade and later in life, the posterior teeth may become a contributing factor to sinus trouble, as long as they remain in their natural positions (see Fig. 1). It is generally known

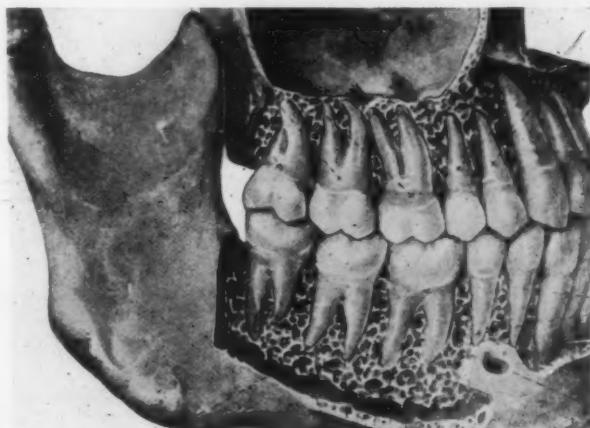


Fig. 1. The proximity and relationship of the roots of the posterior teeth to the antrum. In this illustration the teeth are in their normal position and are invested in healthy, cancellous bone (Spalteholz).

that the structure, shape and size of the antrum varies in most individuals. These variations do not only consist of diversities in the anatomic pattern, but they also include aberrations, abnormalities, malformations, etc. These deviations from the normal in the structural pattern of the antrum interfere with essential physiologic functions, and they often

*The writer acknowledges with thanks the courtesies and material made available for this and other studies to the Departments of Anatomy and Otolaryngology, College of Medicine, University of Cincinnati.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, July 22, 1940.

give rise to pathologic complications. In addition, the teeth and the alveolar process often play an important part toward favorable or unfavorable effects on the health conditions of the sinus cavity. The teeth and especially the alveolar process

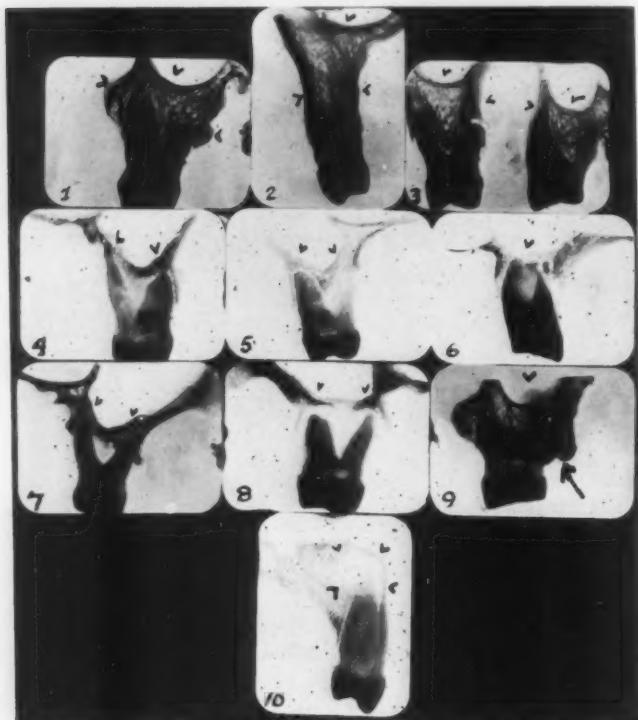


Fig. 2. X-rays of longitudinal sections depicting the proximity of the roots to the antrum. (1-2-3) Relatively normal bone; the roots are a considerable distance from the floor of the antrum. (4-5-6-7-8) The roots are either very close to or entering the floors of the antrums. The necrosis of bone involves the walls and floors of the antrums. The bifurcations of the roots are large receptacles, which retain decomposed waste material, food debris, pus, etc. (9) Embedded tooth with root projecting into the antrum. (10) Granuloma, causing considerable destruction of bone leading toward the antrum.

in some mouths border on a proximity too close to the floor and buccal walls of the antrum. This, in itself, cannot be regarded as a normal condition, as normally there exists a substantial amount of bone in the molar region intervening

between the roots and the floor of the antrum [see Fig. 2 (1), (2), (3)]. By reason of the fact that the dental organism in civilized man has undergone extensive physical and structural alterations, it has deviously departed, in many respects, from one of relative constancy to one of profuse variabilities and aberrations.

Excluding extreme abnormalities and departures from the normal, at least two contrasting features are to be observed in connection with the formation of the roof of the mouth that have a contributing influence in maintaining health or disease in the antrum. One is the high parabolic or paraboloid type; the other is the relatively flat roof (less than a full ellipse). Normally, the high roof and well formed jaws and teeth are buttressed by a heavy formation of bone, which provides protection to the antrum against infection originating either from an abscessed tooth or from a diseased alveolar process. Such protection is lacking in the flat-roofed mouth, where the thin crest of alveolar bone is the sole intermediate between the roots of the teeth and the floor and walls of the antrum. Frequently one finds the root ends of the molar teeth within the antrum. These are barely covered by bone and mucous lining. Although an anomalous condition, the above are not to compare with the deformities and irregularities caused by constricted palates or the prognathism of the upper or lower jaws. The latter conditions affect the shape and size of the sinus cavity and interfere with nasal breathing.

Aside from the ill effects the antrum may suffer from variabilities or aberrations of the jaws and teeth, none compare to the pathologic occurrences resulting from dental disease. From the earliest days of his existence, man began to experience the effects of an ill-designed dental organ. Owing to the peculiar inner structure and being devoid of regenerative power, the tooth is the least resistant to insult and readily succumbs to injury. Whether from a process of decay, injury to the nerve tissue or excessive wear of the tooth, the death of the pulp leads either to acute or chronic complications. It is dead teeth followed by localized abscesses that, obviously, had caused the discomfort and extensive damage to the jaws of man and beast at all times. The examination of skeletal remains of man, where the teeth are partially retained, will

divulge how destructive an element the combination of diseased teeth and susceptible bone can be. This is true of primitive man, as well as civilized man. Not only are large abscess cavities or vast areas of denuded bone to be seen adjacent to a damaged or diseased tooth but often the antrum is penetrated in the molar area. There are instances where this process of destruction penetrated the orbit.

Time and progress evidently did not benefit mankind to an appreciable degree, so far as his teeth are concerned. Overly coarse food (including sand and grit), accidental injuries and the absence of dental aid in emergencies were the chief causes for dental problems among primitive man. Yet, with all available medical and dental knowledge and aid today, man is facing an insurmountable battle to save his teeth. In line with other progressive achievements, the elimination of sand and grit from food was a primary step to safeguard against a needless source of injury to the teeth and jaws; however, the process of food improvement did not end there. So refined has the diet of civilized society become as to leave a very limited function for the chewing mechanism to perform. The examination of anatomic material will leave no doubt as to the influence of modern diet on the muscles of mastication and the bone formation of the jaws and teeth. In most instances, the bone formation of the alveolar process indicates poor development, and the lack of use of the teeth is divulged by the cusps, which remain unworn to the latter stages of life. To contrast the dental conditions between primitive and modern man, it may be said with conclusive certainty that, although the damage to the jaws and teeth of primitive man was often severe, the incidence of such occurrences was relatively small; whereas, today this condition affects all. The same is true regarding the appearance of the sturdy jaws and teeth of prehistoric man, which, no doubt, was due to the vigorous use required by the tough, coarse food. This requirement no longer exists; therefore, it is apparent that a radical change in the diet was a major factor in influencing structural alterations. Excessive alterations in structure and form, ostensibly, were accompanied by cellular tissue changes due to disuse. These changes were the forerunners of degeneration.

The alterations of the jawbone (as revealed macroscopically) consists of variations in the density and thickness of the

compacta and spongiosa, some of which not only fails to provide the necessary support to the teeth but often is a source for pathologic changes. Excluding, for the present, the numerous biological factors that may be responsible for the various pathologic manifestations in bone changes, it is the underdeveloped or thin bone that is the most amenable to insults and disease (see Fig. 3). Among some specimens which I have been exhibiting, two stand out prominently. In one (white male, age about 50 years), the roots of the upper teeth



Fig. 3. In this specimen the exposed roots reveal the lack of support such teeth receive. The poorly formed bone is amenable to degenerative changes.

are barely covered with bone and extensive necrosis has destroyed most of the remaining bone in contact with the roots. In the other specimen (white male, age about 45 years), the bone formation from the alveolar process of the maxilla, including the accessory sinuses, is unevenly and disproportionately distributed (see Fig. 4). In some places the bone is scarcely thicker than paper. The alveolar process, especially in the region of the posterior teeth, has undergone extensive necrosis. These examples are cited not because they represent unusual and isolated occurrences but because in the presence of purulent necrosis of the alveolar process (known as pyor-

rhea) the thin and porous bone is more amenable to infection of the antrum. It is this phase of the suppurative breakdown of the alveolar process, especially in the presence of other anatomic abnormalities, that should be of concern to the rhinologist.

For this occasion a discussion of the morphologic aspects of alveolar pathology is unnecessary and will be avoided, but an attempt will be made to deal with the necrotic phase of alveolar disease which may involve or lead to the infection of the antrum. Commonly known as pyorrhea, this pathologic



Fig. 4. The bone between the buccal and palatal walls is completely gone in the section of the tuberosity as indicated.

process of bone destruction is best studied from Roentgenogram examination. In most instances, this examination will reveal the extent of damage to the alveolar bone, especially in the vicinity of the maxillary sinuses. A further examination made with the aid of a fine probe inserted under the loose gum around the teeth involved should disclose the condition and state of health of the buccal wall of the sinus.

Aside from clinical and X-ray examinations, a further study of the pathologic conditions associated with pyorrhea

are revealed from autopsy material (macroscopic and X-ray) (see Fig. 2). Roentgenogram examination of longitudinal



Fig. 5. Disease of the alveolar bone. (A) Initial stages of bone degeneration, beginning at the first premolar and becoming more severe in the molar region. The tuberosity is undermined in the area indicated. (B) Denuded bone, exposed roots, and the maxillary tuberosity completely destroyed. (C) Alveolar abscess in the lower premolar. Necrotized bone in the upper jaw with all the teeth involved. The area of the antrum suffered the most.

sections of the jawbones of wet specimens, with teeth *in situ*, reveals (third dimension) the diastema beginning at the border crest of the alveolar process, continuing to involve the spongiosa and burrowing into the compacta; all depending upon the density of the bone formation. Aside from the variations of the structural bone formation (which may be either resistant or susceptible to degenerative changes), much depends upon the severity of the destructive process and the degree of damage it will produce within the inner and outer layers of the bone (see Fig. 5). Not only does the crest of the alveolar process and the septa break down or form large abscess cavities but often the process of destruction involves the thickest part of the mandible. That the thinner layers of bone succumb more readily is obvious. All of these manifestations associated with the advanced stages of pyorrhea are analogous to any other form of tissue necrosis, where dying cells continue to be present in living tissue during degenerative changes; therefore, in pyorrhea it is the necrotic bone that results in cellular dissolution and decomposition, terminating in pus formation. The accumulation of dead cells and the wasting of bone when encapsulated by the soft tissue results in pus-discharging pockets. Large abscesses and induration of soft tissue is caused by extensive loss of bone, coupled with the activities of the pus-forming bacteria, the accumulation of dead cells and the lack of drainage.

It may be stated that, in general, the chronic and neglected case of pyorrhea is analogous to a severe type of osteomalacia, destroying both bone and periodental membrane, and the constantly dying cells are ever the source of pus formation and an aid to further bone destruction. This process of bone pathology constitutes the most aggravated and menacing local condition. Much depends upon the degree of severity, the duration of time this condition was allowed to continue, the inherent persisting and predisposing factors involved and local aggravating factors, whether confined to isolated teeth or areas, or whether the entire dentition is involved. Occasionally, such derangements may be confined to a single tooth or a few teeth scattered at distant parts of the mouth. In such cases local insults may be responsible for the breakdown of the bone and the tooth or teeth affected are doomed. The pus, if allowed to collect, will undermine the support of the adjacent teeth. In the multirooted teeth it will often attack

one or two roots, where not a vestige of bone is left to protect them. Clinically, it is to be observed that the ever present infection from food debris, bacterial activity and the by-product of dead bone cells results in a profuse discharge of pus,

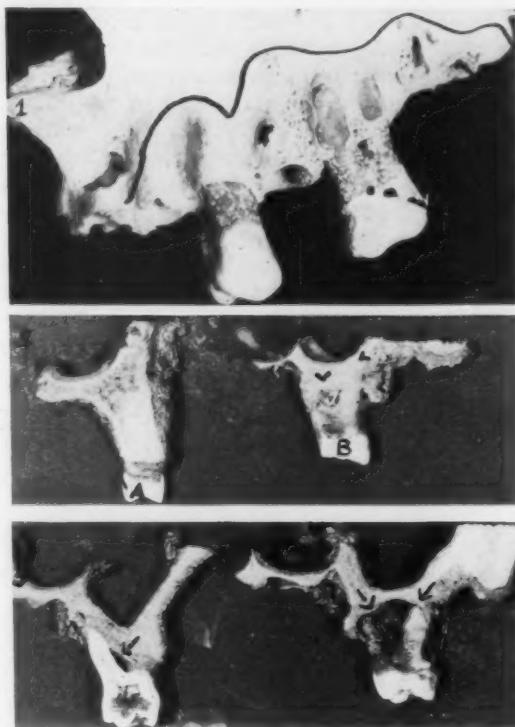


Fig. 6. (1) Necrotized bone involving the alveolar process from the canine socket to the tuberosity of the jaw, where the damage is most extensive. (2) Longitudinal sections of the maxilla showing the floor of the antrum and the teeth. (A) is a normal condition; (B) is the extreme contrast. (3) Longitudinal sections of the maxilla showing spaces between the roots of the teeth where there is a visible collection of debris.

combined with blood exuding from small blood vessels of the highly irritated and inflamed gum. A loop full of the contents from such a pocket reveals, beside the pus and blood cells, a myriad of mixed bacteria the mouth is known to contain. Upon the removal of such a tooth, one invariably finds that

the roots are covered with a nondescript mass of adherent debris mixed with thick pus and blood, firmly attached fibre fragments, or encapsulatd single or mutiple highly inflamed polypoid tissue. The bifurcations of the molar roots offer an especially favorable receptacle for the slimy, malodorous mass to collect (see Fig. 6). Very often one root, or part of one, is the sole support of the entire tooth, depending upon the duration of time the tooth or teeth have been in need of attention. Where free drainage is not possible, the continuous infection from a single tooth will lead to the destruction of a large area of bone, often penetrating the antrum. In all such types of pyorrhea the bone degeneration universally affects both jaws, although the dissolution is not uniform nor is it evenly destroyed. The surface bone is denuded or jagged, as though worm-eaten. Postmortem examinations of the necrotic type of pyorrhea reveal the entire socket denuded and porous. Unquestionably, this is the most pernicious type of chronic mouth disease. Locally, it leads to the loss of the teeth, completely absorbing the alveolar process and the tuberosities of the jaws.

It is obvious that there cannot be a specific treatment for a derangement of a nonspecific cause. Alveolar pathology is not only as old as man himself but it prevails among the lower forms of mammalia; the exception being that in man this derangement became more persistent and more progressive. The known remedies attempted often parallel those of the ephemeral and even empirical therapies of early medical history. Recurrent enthusiasm for newly discovered panaceas are being constantly introduced, notwithstanding the evidence that the disorder does not concern a disease existing in man, but rather *man's predisposition to disease*. The only reasonable treatment that may spare the body from the ravages just related is to keep the investing tissues free from mechanical irritation. This consists of thorough mouth hygiene, frequent periodic dental attention and, finally, the extraction of such teeth that may prove a menace to their possessors.

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